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ABSTRACT

The first of four main sections of the electrical occupations curriculum guide is an introduction which describes the design and use of the guide and which provides five pages of suggested curriculum resources. Section two contains job descriptions for 18 electrical occupations. For each occupation the guide explains industry's expectations of the person performing that job and outlines the basic skills that must be learned to gain an entry-level job. Section three contains 50 educational blocks of specific skills or portions of a skill that needs to be learned, each of which provides references, a general objectives, and a topical outline specifying skill objectives and recommended time. Each job description in section two makes specific reference to the appropriate educational blocks in section three, thus providing a cross reference between the two sections. Part four is an appendix which illustrates such things as electrical charts, forms, abbreviations, tables, symbols, and equipment, and provides a glossary, a list of references, and criteria for placing handicapped students. (JR)

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ELECTRICITY OCCUPATIONS

CURRICULUM GUIDE

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JULY 1975

The curriculum guide was developed pursuant to a contract with the Illinois Office of Education, Division of Vocational and Technical Education, under a contract entitled, "A Proposal to Design and Publish Industry-Based Curriculum Guides in Electricity-Electronics Occupations". This guide represents one of a two volume curriculum guide written under that contract. Points of veiw or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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The project staff would like to take this opportunity to thank the following Steering Committee members and the industries and educational institutions that they represent for their continued support of the project. Their input was greatly appreciated, and was vital to the success of our efforts to product effective industry-based curriculum guides for high school electricity-electronics instructors.

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SOURCES OF JOB SKILL AND TRAINING PROGRAM INFORMATION

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Illinois Central Gulf RAilroad, Chicago, Il.
Monsanto Company, Sauget, Il.
American Line Builders Apprentice Training, Champaign, Il.
Illinois Power Company, Champaign, Il.

Following are some comments made by Steering Committee members:

I. From Richard Burritt, Training Supervisor, Caterpillar Tractor Company

The electricity-electronics curriculum guides are valuable tools for course development at the secondary school level. Because of job diversification within the electricity-electronics field, a specific job objective can be achieved only through properly directed training. These guides will give the proper direction to this training.

II. From David Timmersman, Jr., Engineering Supervisor, Module Engineering, Micro Switch, Division of Honeywell.

Education has a wonderful way of flattering the world of industry while calling its bluff. Being asked to serve on TERC's Electricity-Electronics Curriculum Guide Committee was a threat, a challenge and a compliment all in one. Therefore, although I accepted the invitation to serve with great reservation, I completed the assignment with fascination.

In my opinion, the interface generated by TERC in our several meetings was singularly productive. I have no hesitation in concluding that the curriculum guide established by (the project staff) meet the requirements of industry. I am sure that this guide will be a constructive vehicle for the dedicated teachers who will be conducting the high school electricity-electronics programs throughout the state. Keeping the course interesting will be the key!

It was an honor to have been asked to share my experiences with you, my fellow industrial representatives and the selected teachers from the Illinois public schools.

III. From M. A. Wittevrongel, Coordinator-Consultant and Electricity/Electronics Consultant, Granite City Steel

Please accept my thanks for the privilege of serving on your Electricity-Electronics Steering Committee. It was a most rewarding experience. I was impressed by the support this undertaking generated in the industrial and service community. The potential employer's intense interest in helping to establish basic instruction in the public schools was most heart-warming. Their candid analysis of the instructor's problems makes one realize that school's efforts are not unappreciated, and that industry is standing just outside the door, waiting for an invitation to come in and help.

From the committee interest exhibited, I believe that this project was long overdue and will prove to be a real asset to the vocational electricity-electronics programs in Illinois.

IV. From E. F. Olver, Professor, University of Illinois.

In my estimate no subject matter is more important today in our technical society than the Electricity-Electronics materials developed by our steering committee for high school classes. It is a most neglected area. The staff of TERC has done a fine job. I have been very pleased to participate in this vital program.

V. From Robert A. Billing, Service Area Engineer, Illinois Power Company.

I want to thank you for inviting me to be a member of your Electricity-Electronics Steering Committee. I am indeed appreciative of the fact that I could contribute my small part to the large task that you undertook.

I believe that the Electricity/Electronics Curriculum Guide will be a great aid to the Vocational Instructor. It will help the Instructor to formulate his course of study and direct his efforts to the occupational units most needed in his immediate area.

It has been a pleasure working with (The project staff). If I can be of any future service to you, please feel free to call me.

INTRODUCTION

Given our current economic situation, it is more important than ever that a teacher in vocational electricity-electronics have the tools to prepare his students to go directly into industry at the end of their courses. The instructor, therefore, has a responsibility to continually keep himself assessed of the state of the art in the field of electricity and electronics. Up to the present, however, it has been difficult for an instructor to find the materials and curriculum that would help him achieve that goal. This lack has been due primarily to a lack of communication between industry and the instructor and the curriculum that he has been using. Robert L. Stark and Sharon Chace of Technical Education Research Center, Inc. (TERC), with David A. Peterson and Robert L. Laursen from Parkland College, have developed a unique set of curriculum guides which can fill this communication gap. The Electricity-Electornics Curriculum Guide Project was funded under a contract grant from the State of Illinois Board of Vocational Education and Rehabilitation, Division of Vocational and Technical Education. The guides are divided into two main portions: a job skills portion which lists and describes entry-level jobs; and an educational block portion which outlines educational experiences needed to learn the job skills. In addition to the two main portions the guides contain descriptive introductory material, a cross-reference system which indexes the two main portions, and several appendixes of supporting material.

PROJECT OPERATION

The curriculum project was initiated on September 1, 1974, when the Division of Vocational and Technical Education of the State of Illinois approved a proposal submitted by Technical Education Research Centers entitled *"A Proposal to Design and Publish Industry-Based Curriculum Guides in Electricity-Electronics Occupations"*. The purpose of the project was to design and publish two separate industry-based curriculum guides to help high school vocational instructors develop, teach and evaluate their electricity and electronics programs. Emphasis was placed on the development of curricula that would either enable the student upon leaving high school to be employed in an entry-level electricity or electronics job, or that would adequately prepare him for the post secondary training programs which some electricity-electronics job occupations require.

The project was implemented in four phases. The *first phase* was concerned with identifying and defining entry-level electricity and electronics occupations in Illinois; the *second phase* involved the compilation and evaluation of a skills list for each job occupation established in phase one; the *third phase* was concerned with the corelation of the occupational information with appropriate curriculum activities; and the *fourth phase* was concerned with the writing and publication of the two guides.

INDUSTRY-BASED STEERING COMMITTEE

Each of these phases was accomplished through a series of continuing and interrelated project activities. One of the most important of these activities was the organization of an industry-based Steering Committee. The purpose of the committee was to ensure that persons familiar with industry and industrial training programs were available to provide input to the development of the guides. The Steering Committee and project staff met regularly through out the progress of the project. As a unit, the committee functioned to provide a sounding board for staff research and development activities. Individually, steering committee members assisted by contributing curriculum materials, by arranging for on-site visititations to industrial training centers and in many other ways. Using the valuable insight of steering committee members selected from industries and public schools who were familiar with industry-based training, it has been possible to compile curriculum guides which coordinate the present demands of industry with the practical problems of teaching in the classroom.

INDUSTRY OCCUPATIONAL INFORMATION

In addition to the input provided by Steering Committee representatives, occupational information was solicited from two hundred industries listed in the Illinois Manufacturer's Directory. A letter was mailed to the personnel director of the industries requesting job title and description information for entry-level electricity and electronics positions in the firm. Follow-up letters were sent to those industries that did not answer the initial communication. A record was kept of the responses received from the various industries contacted and relevant information and materials were incorporated into the project.

OCCUPATIONAL LITERATURE AND CURRICULUM MATERIALS

At the same time that job title and description data was being compiled the staff was conducting a literature and curriculum materials search. The purpose of this search was to supplement input obtained directly from industries and also to provide data on training programs and curriculum materials being utilized across the country in schools and in in-house training programs. Information concerning electricity and electronics job titles, descriptions and required skills was obtained from steering committee members, participating industries and resource references such as the Occupational Outlook Handbook, the Job Description and Classification Manual, the Concise Handbook of Occupations, and the Dictionary of Occupational Titles.

DESIGN OF THE CURRICULUM GUIDES

Through the planning stages of the guides, it became evident that basing the curricula on industry and their expectations of performance was a valuable way of helping teachers and their students. As different industries shared descriptions of their entry-level jobs for people in electricity and electronics related fields it was clearly seen that if instructors could be made aware of these requirements and had a source book that could tell them in what relative order these requirements or skills might be taught, then students would be better prepared for entry-level jobs. This became the underlying reason for setting up the guides in two main portions.

A *"Job Skills"* portion explains the types of jobs available, tells the expectations of industry in the performance of that job, and then outlines the basic skills that must be learned to gain an entry-level job. The second portion of the book is set up into *"Educational Blocks"*. Each block handles a specific skill or phase that needs to be learned and then gives references, a topical outline for teaching the skill, and suggested time allowances. The electricity-electronics curriculum guides have a unique *cross-referencing system* which ties the *"Job Skills"* portion containing information on jobs in industry to the *"Educational Block"* portion in a way that will allow each teacher to select and adapt his course material to the industrial and vocational needs of his area. This allows the teacher to look into local industry and their needs and assess what entry-level jobs he can prepare students for; and then go to the guides to pull out job skills and educational blocks that would fit his students' needs and interests. He can assure his students of precise industrial training for entry-level jobs because he has at his disposal all the information that he needs. It is expected, of course, that each instructor also brings his own "hands-on" experience and background to the course.

In utilizing the *"Educational Blocks"* the instructor should be aware of the fact that the references, outline, and time allowances are merely suggested and should be adjusted according to the needs of the course, the instructor, and the student. For instance, the references that are listed in the *"Educational Blocks"* are not suggested textbooks for student use, but rather are listed to be used by the instructor as an additional source of information. There will also be a different emphasis on various parts of the outline, which will be dependent on the job or occupation for which training is being given. In using the recommended topical outline the instructor can pick and choose from the topics depending on the jobs or occupations chosen and the topics previously covered by the student. The instructor should also be aware of the fact that the recommended time allotments listed for each topics in the *"Educational Blocks"* is approximate and may vary from one course of study to the next. Different occupations often require different levels of skill competence for the same skill, and some of the skills are primarily cognitive while others are more manipulative in nature and may require more time for skill competency. Therefore, the instructor should carefully calculate the amount of time he believes he needs to spend on each topic in the outline.

The type of program, the job skills students are prepared for, and the depth that the material is covered will be determined and adjusted by the local needs, the needs of the students, and the background of the instructor. To adequately utilize the suggestions and recommendations listed in the guides each instructor would need to assume a great deal of responsibility in designing his own curriculum. The instructor would certainly need to think of how a new program based on the curriculum guides would fit into his school. For example, since this is a rather specialized career preparation course, is there a career orientation course in electricity-electronics that might serve as an introductory course which a student might take prior to the specific job skills material offered through the curriculum guides? Possibly the instructor might wish to use the curriculum guides to revitalize an existing program rather than initiate a new program. In many cases, the instructor will be working with a large group of students learning the same job skills, whereas in other cases the student may be working completely alone and separately with an individualized curriculum.

Whether this course is being taught in a high school or area vocational center would also affect the way the instructor wished to present it. If the course of study can only be pursued for five hours a week rather than ten or fifteen, the depth of the presentations and the level of skill preparation will be proportionately affected. All of these options would require a different type of orientation and preparation, but they could all utilize the basic material presented in the curriculum guides as a beginning outline for formulating a course of study.

Obviously, all occupations are not covered in the *"Job Skills"* portion of the guides, but we feel that the basic skills as outlined in the *"Educational Blocks"* and the procedure used to develop the guide will enable the instructor to design a curriculum for any electricity-electronics course. The *Cross-Reference* (Page 3-1) shows that there is a cluster of skills applicable to all occupations; i.e., Safety, Basic Electrical Parameters, Component Identification, etc. This information can serve as a base for developing other curriculum. By utilizing the *Cross-Reference Chart* and input from a local Steering Committee or Advisory Committee, an instructor should be able to design a curriculum to fit any occupation desired.

HOW TO USE THE CURRICULUM GUIDES

1. To develop an industry-based program, the instructor should first identify and select entry-level occupations that are available in his area. Advisory committees, the Chamber of Commerce, telephone directory yellow pages, and input from local businesses and industry personnel are some of the sources available to the instructor to help him identify and select local entry-level occupations.
2. After determining a list of entry-level occupations in the area, the instructor should match these selected occupations to the relevant occupational units given in the first portion of the guides. The occupational units identify the skills *(Special Skills Required)* that a student is likely to need to be hired into an entry-level position in a particular occupation (such as residential electrician).
3. From the specific skills listing, the instructor is referred to an appropriate educational block (the second portion of the guides). The educational blocks are subdivided into tasks that must be mastered in the classroom before the skill has been learned. Each task is accompanied by a *recommended topical outline* that identifies the material to be covered. The educational blocks also include a *sequence chart* to help the instructor determine the order in which topics are to be covered, a *recommended time section* that gives the instructor an estimate of the time required to cover the material, and *suggested procedures* to help the instructor with suggested ideas and training aids.

4. AN EXAMPLE: You have determined from your local IBEW that there is a demand for residential electricians in your locale. Since many of the students in your electricity class plan to remain in the area, and are interested in the topic, you turn to the occupational unit portion of the Electricity Curriculum Guide where you locate the occupational unit entitled "Residential Electrician". This unit notes what kinds of skills the student will probably have to be adept at when he applies for a job as a residential electrician. One of the skills listed in the *Specific Skills Required* section refers to the need for the individual to have a grasp of standard safety practices and procedures and OSHA standards. A notation has been included by this particular skill that Educational Block I.10 will help you teach your students about safety. You turn to block I.10 which provides a list of tasks to be mastered (i.e., "know first aid procedures") accompanied by a *recommended topical outline.* You follow this sequence through each job skill listed under Residential Electrician, noting the suggested sequence of tasks to be covered, the time involved, and the suggested procedures as you go along.

5. It must be emphasized that the guide is meant to provide a set of guidelines, and the instructor should be continually ready to modify its contents to fit the materials and equipment available to him; the time available to him; and to fit his own interests and abilities.

GENERAL INFORMATION

THE UTILIZATION OF SCHOOL AND COMMUNITY RESOURCES

As talks with members from industry progressed in the planning of the curriculum guide, it became evident that industry is very concerned and interested in the preparation of youth for industrial jobs. Local industry can play a major role in helping to define the skills that a high school student will need to be hired into jobs in the community. The instructor should arrange to visit various local industries and become acquainted with their operations. The instructor might also arrange for industry to provide personnel such as foremen, supervisors, personnel managers, etc., to come and talk to students about individual phases of the work being learned. In addition, many industries and businesses would welcome the oppertunity to provide input to the development of high school training programs by providing representatives to serve on advisory committees. Industries could arrange for tours of their plant, and provide pertinent pamphlets and audio visual materials, and might also supply equipment for high school programs and classes that are operating on a limited budget. Another source of inexpensive equipment, including surplus electric and electronic parts, is government surplus depots such as the ones located at St. Charles and Springfield, Illinois.

The instructor should strive to keep other members of the school vocational and academic staff informed of what he is trying to accomplish so that cooperative activities that reinforce the student's learning can be developed. For example, the counseling staff would certainly be an asset in areas such as work attitudes and in helping to place students into job situations. In addition, since many students will continue their education beyond the secondary level, there is need for high school instructors to open and maintain lines of communication with community colleges and universities to help in the mutual understanding of educational goals and to maintain a high school training program which will most benefit the student in future educational situations.

Thus, the instructor's close articulation with industry, with staff members in school, and with college and university are all valid and necessary activities which interact to establish and maintain a relevant program in electricity-electronics.

WORK ATTITUDES

An individual's work attitudes often have as much to do with their finding and keeping a job as the type and extent of their training. In many jobs contact with the public is an integral part of the job and the impression that the individual portrays to the public influences their impression of the company or organization. Employers look for employees who will convey a favorable impression by their appearance, manner, and conversation, because the employee will be a representative of the company or organization.

The type of attitude the student has toward people, toward his school program, and toward his school is often indicative of the type of attitude he will have toward his job. Often an employer is not as interested in a student's grades as in his attendence, his punctuality, how he gets along with others, and what he participated in when he was attending school. Since these qualities are so important to the employer when a student applies for a job the instructor should place a great deal of emphasis on them in any education program. The student should know and be aware of the fact that a negative attitude can narrow his chances and cause him to be passed over not only when he is seeking a job, but when promotions are being considered. A positive attitude can aid the student in succeeding on the job, in his personal life and in the community. When an individual has a positive attitude he is motivated. An individual who has a positive attitude and who is motivated will likely develop positive attitudes about his job, his supervisor, his company, and the organization. This is the type of employee an employer wants to hire. The following list of statements concerning the type of qualities wanted from employees was formulated by employers at a recent workshop meeting and reflects their desire to hire employees with good work attitudes.

I WANT AN EMPLOYEE

... Who likes his job -- who knows his job.

... Who is always on the job unless excused.

... Who keeps himself physically fit.

... Who gets a bang out of a job well done.

... Who wants to do a day's work for a day's pay.

... Who wants to get ahead -- who is cheerful, not sullen.

... Who works safely -- with due consideration for himself and his fellow-worker.

... Who tries to avoid waste and cuts cost.

... Who looks for a better way to do the job.

... Who tells the truth, who is sincere.

... Who keeps a spirit of teamwork.

... Who gripes little and looks forward.

... Who asks questions when he needs help.

... Who is willing to face his personal problems squarely.

... Who tries to put himself in my place now and then.

... Who feels that his job is a privilege -- not a right. I would give a worker like that my best. You would too!

SAFETY

In a national survey, mentioned in the section on *Work Attitudes*, business administrators and personnel managers look for employees who work safely - with due consideration for themselves and their fellow-workers. This important aspect of work is covered in a unit in the guides (Safety, I.10) and provides the theoretical tools and background to safety practices in the world of work. However, safety is more than a theory or learning to use first aid; it is a habit to absorbed and used in practice on a daily basis in the classroom.

While an instructor is constantly aware of keeping up with new innovations and ideas in the world of electricity-electronics, perhaps it is not so usual to keep up with new innovations in the area of electricity-electronics *safety*. An occasional look at manuals and special articles on safety such as "An Accident Prevention Program for School Shops and Laboratories" by the U. S. Department of Health, Education and Welfare, Office of Education can be of great help in upgrading this particular area.

It is of vital importance that a teacher develop a permanent safety consciousness in students through his own example - always doing things the safe way. As a teacher works with his students he should teach accident prevention with a positive approach by stressing the right way to perform an operation and giving shop demonstrations emphasizing the safe use of hazardous machinery and of specific hand tools. As part of the daily classroom routine, a teacher should strive to develop in each student a sense of responsibility for his own safety and that of others, helping him recognize potentially hazardous situations and what safety practices he should be using in his day-to-day activities.

An instructor should also be aware of his own personal responsibility for the routine housekeeping procedures required in his shop or lab. This not only ensures a suitable working environment for the students in class; but also demonstrates one of the important aspects of safety consciousness; working in clean, clutter-free surroundings. The teacher should be sure that all work areas are being cleaned, that storage is provided in a safe area, and that proper cleaning equipment and solvent materials are being used. A routine check of electrical equipment is a necessity. Periodically an analysis of all hazards in the area involving machines, hand tools, and general environment should be made and steps should be taken to correct potential hazards before they develop into accident-causing situations.

One recent resource presently on the market that may prove helpful is entitled:

> Occupational Safety and Health Standards for General Industry, (Commerce Clearinghouse, Inc.: 4025 W. Penterson St., Chicago, Illinois 60646), amended through June 3, 1974.

CURRICULUM RESOURCES

The following curriculum resources are included to assist the instructor in locating information and agencies to help in planning and implementing an industry oriented curriculum. The information provided is common to many industrial jobs and is also common to many of the educational blocks, so it is listed here rather than in each specific educational block.

GOVERNMENT MATERIALS

Many instructors overlook government materials when they are looking for resources to use in planning their instructional programs. Possibly this may be due to the fact that government materials are not always easy to find nor are most instructors familiar with how to locate the materials even when they are available. Actually, an instructor can find many publications just by being familiar with a few government documents that are regularly issued and know how to use them.

One of the most useful government documents printed on a regular basis is the Monthly Catalog. It is issued monthly and is a requisite in any researching of government documents. The Monthly Catalog lists the majority of all Government Printing Office publications under the name of their issuing agency. Each monthly issue has an index which lists, by subject, all the publications for that month. To find a document the instructor looks under the subject heading for the relevant title where both the title and the index number are listed. The index lists the index number on the left-hand side of each page. Once this number is determined, the complete description can be located by finding the number in the main portion of the catalog. The index of the Monthly Catalog is accumulated each December and allows the instructor to search the entire year's publications in one index. The Monthly Catalog costs $7.00 per year and may be ordered by writing the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

A second source that is helpful is the pamphlet Selected United States Government Publications, catalog number GP3.17. It is a free pamphlet and is mailed on request. Other government publications that may prove of interest are the Occupational Outlook Handbook, the Job Description and Classification Manual and the Dictionary of Occupational Titles.

The Northwest Regional Education Laboratory, 500 Lindsay Building, 710 S.W. Second Avenue, Portland, Oregon 97204, issues the publication entitled Vocational Instructional Materials for Trade and Industrial Occupations Available from Federal Agencies. The ERIC Clearinghouse on Vocational and Technical Education, Ohio State University, 1900 Kenny Road, Columbus, Ohio 43210, also publishes two useful publications. These are Abstracts of Research and Related Materials in Vocational and Technical Education (ARM), and its companion publication Abstracts of Instructional Materials in Vocational and Technical Education (AIM).

CURRICULUM GUIDES, COURSES OF STUDY, AND SPECIAL REFERENCES

There are many materials available from schools, commerical sources, and other publication sources that are also very useful to the instructor. Many of these publications can be found in the reference Books in Print (BIP). A second reference that may prove even more valuable is the Subject Guide to Books in Print (SGBIP). Following is a listing of some references which may prove useful to the instructor in electricity:

Suggested Guidelines for Developing a High School Trade and Industrial Program in Construction Electrician. Trade and Industrial Education Services, State Office Building, Columbus, Ohio 43216, 1968.

Learner's Manuals - Electric Lineman, Series 100-400, Ohio Trade and Industrial Education Service, State Department of Education, Columbus, Ohio 43216.

Over 2,000 Free Publications, Frederick J. O'Hara, Signet Reference Books, New American Library: 1301 Avenue of the Americas, New York, New York 10010.

Electrical Wiring, California State Department of Education Sacramento, California, 1971.

Industrial Electricity Curriculum Guide, State of Maine, Department of Education, Augusta, Maine, 1971.

Electrical Construction (Interior Wiring), A Course of Study Department of Industrial Education, College of Education, University of Missouri, Columbia, 1967.

Apprenticeship Schedules Covering Electrical and Electronic Trades, U.S. Department of Labor, Manpower Administration, 1970.

Electricity-Electronics Occupational Cluster Guide, Oregon Board of Education, Salem, Oregon, 1969.

1974-75 Catalog of National Electrical Course Materials AJC7. National Joint Apprenticeship Training Committee for the Electrical Industry, National JATC, Rm 415, 1730 Rhode Island Avenue, N.W. Washington, D. C. 20036.

EDUCATIONAL SERVICES OF MANUFACTURERS AND GOVERNMENT AGENCIES

Many manufacturers and government agencies commonly send out or give away large quantities of educational materials. The Illinois Manufacturer's Directory is a commonly used source for locating Illinois manufacturers. The Thomas Register is a listing of major U.S. manufacturers by product type as well as by name. These references plus the Encyclopedia of Associations will give the instructor enough information to prepare lists of manufacturers and organizations to write for industrial information. Some typical government agencies and manufacturers supplying educational materials are:

a. Education Program Branch
NASA
Kennedy Space Center
Florida 32899

b. Education Programs
NASA
Manned Spacecraft Center
Houston, Texas 77002

c. Hickock Teaching Systems, Inc.
Woburn, Massachusetts 01801

d. Hampden Engineering Corporation
East Longmeadow, Massachusetts 01028

e. Feedback Inc.
Berkley Heights, New Jersey 07922

f. Digiac Corporation
Smithtown, L.I., New York 11781

g. Fabritek
Los Angelos, California 90023

INDEXES TO POPULAR AND TECHNICAL MAGAZINES

There are several resources printed regularly to assist the instructor to locate material in magazines and periodicals. Probably the best known is the Reader's Guide to Periodical Literature, which lists author, title and subject together alphabetically. The Reader's Guide is issued monthly and is compiled on a yearly basis. Another resource similar to the Reader's Guide that would be of help to the instructor is Science and Technology Index.

TRADE JOURNALS AND MANUFACTURERS MAGAZINES

Much helpful information can be obtained from trade journals, manufacturer's magazines, or other informational publications. Articles on new products, product ratings and indexes are quite helpful, and many product ads have data retrieval cards or addresses where product information can be obtained by writing the manufacturer. Some of these trade journals and magazines are listed below:

a. Trade Journals

Transmission and Distribution (Lineman), Clemworth Publishing Co.

Undergrounding (Lineman), Asman Corporation

Electrical World (Lineman), McGraw-Hill, New York, New York

Contractors Electrical Equipment (Electrician), Sutton Publishing Co., White Plains, New York

Electrical Construction and Maintenance (Electrician), McGraw-Hill, New York, New York

Electrical Contractor (Electrician), National Electrical Contractors Association, Washington, D.C.

Electrical Equipment, Sutton Publishing Co., White Plains, New York

Electrical World (Electrician), McGraw-Hill, New York, New York

Electricity in Building,(Electrician), Electrical Information Publications, Inc., Madison, Wisconsin

Electricity on the Farm (Ag Electrician)

b. House Journals

Chance Tips (Lineman), A. B. Chance Co., Centralia, Missouri 65240

Norelco Reporter, Phillips Electronics Instruments, Mount Vernon, New York

Mueller Clipper, Mueller Electric Co., Cleveland, Ohio

Garybar Outlook, Gary Bar Electric Co., New York

AUDIO-VISUAL MATERIALS

There are super 8mm film loops, 16mm films, video tapes, slides, filmstrips, tapes, tapescripts, transparencies and charts available from many sources to supplement a large portion of the subject matter contained in most electricity-electronics programs. Many of these aids can be rented for a nominal fee, and some are available at no cost to the school. A list of these materials has been compiled, cataloged and published and is available for the instructor's use. The handbook/catalog lists materials by type and topic with a short review of each item including the order source and cost of each aid. Compilation of the 224-page handbook was sponsored by the Electronics Industry Association (EIA) and edited by Dr. Irving W. Larson of Bemidji State College, Bemidji, Minnesota. The instructor can obtain a copy of the EIA Electronics Multimedia Handbook edited by Dr. Irving W. Larson through Howard W. Sams and Co., Inc., Indianapolis, Indiana.

CONFERENCES, WORKSHOPS AND TRADE SHOWS

Conferences, workshops and trade shows can help the instructor become acquainted with new products or training aids in addition to making important contacts with cooperating industries. One such trade show that is held yearly is the "Electrical Trade Show (A to Z)" which is held in St. Louis, Missouri. Similar information can be obtained by belonging to technical organizations and attending their meetings, conferences and workshops. Following is a brief list of some of these organizations which are based in Illinois:

IAEE (Illinois Association of Electricity and Electronics Educators)
IVA (Illinois Vocational Association)
IIEA (Illinois Industrial Education Association)
IIAA (Illinois Industrial Arts Association)
IFEC (Illinois Farm Electrification Council)

JOB TITLE Electrical Appliance Set-Up Man DOT # 827.884-030

USOE # 17.0201

EMPLOYING INDUSTRIES Appliance Stores and Appliance Departments of Large Stores

JOB DESCRIPTION:

Uncrates, assembles and tests electrical appliances such as ranges, refrigerators, etc. to prepare them for delivery and installation. Performs visual inspection of appliances for defects. Keeps records of appliance delivery and storage. Delivers large appliances to customer. Installs, adjusts and connects appliance to electricity, gas, water, etc.

CREDIT: Advisory Committee.

Electrical Appliance Set-Up Man

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2. Define basic electrical parameters, their characteristics, units and interrelationships in circuits containing resistances.	0.14.a
3. Read and interpret manufacturer's manuals and literature.	I.11.a, I.11.c, 0.16
4. Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
5. Install and connect large appliance circuits and plumbing.	I.19.a, I.14, I.64
6. Unpack and uncrate appliance from its shipping container.	I.21
7. Assemble disassembled units using manufacturer's assembly specifications.	0.13.a, I.11.c
8. Perform incoming inspections to detect damage using manufacturer's inspection specifications.	I.11.c
9. Perform preliminary tests and dealer maintenance and service in accordance with manufacturer's instruction manual.	I.11.a
10. Move or transport appliances using handcarts and dollys.	I.21
11. Use and care for basic hand and power tools.	0.13.a
12. Properly use cleaners and lubricants.	I.25
13. Explain problem and corrective measures to customer and/or supervisor.	0.80

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	014a	016	I11a	I11c	I12	I25	013a	I19a	I14	I21	I64
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NUMBER	080											
PAGE	3-108											

JOB TITLE Electrical Appliance Serviceman DOT # 827.881

USOE # 17.02

EMPLOYING INDUSTRIES Appliance and Large Department Stores

JOB DESCRIPTION:

Appliance serviceman installs, adjusts, diagnosis, and repairs large electrical appliances such as: washers, dryers, refrigerators, freezers, dishwashers, stoves, ovens, electronic ranges, disposers, icemakers, air conditioners, etc. The diagnosis and repair is usually done in the customer's home or place of business. The serviceman is often required to estimate the cost of repairs and advise whether the unit should be repaired or replaced. The serviceman requires some skills of the plumbing, electrical and electronic trades. Electrical appliance serviceman tends to specialize on one group of appliances such as washers and dryers. The work involves using special tools and test equipment to locate and repair the fault. His appearance should be presentable and he should be able to get along and communicate with the customer. He should be able to work diligently and safely without supervision.

CREDIT: Marvin Lichti, Colbert's Kitchens, Champaign, Illinois.

Electrical Appliance Serviceman

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and following established safety practices, procedures and OSHA Standards.	I.10
2. Locate, read and follow applicable provisions of local, state and national electrical and plumbing codes.	I.12
3. Read and interpret electrical/electronic plumbing and mechanical installation diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.b, I.11.c, 0.17
4. Identify electrical/electronic components by physical characteristics, color codes, etc.	0.16
5. Identify and troubleshoot common electrical/electronic circuits including single and three phase motors, motor controls, heating elements, fan, valve, switching, timing, etc. found in major appliances as listed under description.	*I.20.a, 0.20.a, 0.18, I.18, I.34
6. Identify, install, troubleshoot and repair basic plumbing systems including water and refrigeration.	I.63, I.64
7. Use basic refrigeration test equipment and be able to silver solder.	0.50, I.24
8. Use multimeters, current probes, thermocouples and wattmeters.	I.19.a, I.19.b
9. Use and care for basic hand and power tools.	0.13.a
10. Properly use cleaners and lubricants.	I.25
11. Install large appliance circuits including correct wire size, circuit breaker and receptacle in accordance with local codes.	I.13.a, I.14, I.15, I.45
12. Define basic electrical parameters, their characteristics, units, interrelationships in circuits containing resistors, capacitors and inductors.	0.14.a, 0.14.b
13. Explain problem and corrective measures to customer and/or supervisor.	0.80
14. Keep clear and concise records of work performed.	0.26

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	014a	016	017	I11a	I11c	I12	013a	050	I19a	I19b	I13a
PAGE	3-4	3-6	3-8	3-12	3-20	3-24	3-26	3-30	3-32	3-34	3-36	3-38
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NUMBER	I64	080	026									
PAGE	3-106	3-108	3-112									

*Reference: Electrical Appliance Servicing Group Instruction, A Course of Study, Department of Industrial Education, University of Missouri, Columbia, Missouri.

JOB TITLE Electrical Appliance Repairman DOT # 723.381

USOE # 17.0201

ALTERNATE TITLES Small Appliance Repairman

EMPLOYING INDUSTRIES Appliance Stores

JOB DESCRIPTION:

Appliance repairman tests, adjusts and repairs small electrical appliances, such as toasters, cookers, percolators, lamps, and irons, using hand tools and electrical testing instruments. Examines appliance for mechanical defects and disassembles it. Tests wiring for broken or short circuits, using voltmeters, ohmmeters, and other circuit testers. Replaces defective wiring and parts, such as toaster elements and percolator coils, using hand tools, soldering iron, and spot-welding equipment.

CREDIT: Advisory Committee.

Electrical Appliance Repairman

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2.	Read and interpret wiring diagrams, schematics, and manufacturer's manuals and literature.	I.11.a
3.	Define basic electrical parameters, their characteristics, units and interrelationships in circuits containing resistors, capacitors and inductors.	0.14.a, 0.14.b
4.	Demonstrate knowledge of circuits, series, parallel and series-parallel by determining unknown parameters.	0.15
5.	Identify electrical components by their physical characteristics, schematic symbols, color coding or printed specifications.	0.16
6.	Identify the function and applications of common circuit components.	0.17
7.	Install, connect and maintain AC motors.	I.18
8.	Operate a spot welder.	I.24
9.	Test operation, locate and repair trouble in small appliance circuits including motor, fan, pump, timer and light circuits.	I.18, I.20.a*
10.	Clean and adjust timers, contacts, thermostats and brushes.	I.25
11.	Use and care for common hand and power tools.	0.13.a
12.	Use basic test and measuring instruments.	I.19.a
13.	Use basic solder tools and perform basic soldering techniques.	0.50
14.	Explain problem and corrective measures to customer and/or supervisor.	0.80
15.	Keep clear and concise records of work performed.	0.26

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	014a	016	017	015	I11a	I25	013a	050	I19a	I18	I20a
PAGE	3-4	3-6	3-8	3-12	3-14	3-20	3-28	3-30	3-32	3-34	3-54	3-60
NUMBER	I24	014b	080	026								
PAGE	3-64	3-66	3-108	3-112								

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*Educational Reference: Electrical Appliance Servicing Group Instruction, A Course of Study, Department of Industrial Education, University of Missouri, Columbia, Missouri.

JOB TITLE Residential Electrician DOT # 824.281-014

USOE # 17.1002

EMPLOYING INDUSTRIES Electrical Contractors, Self Employment

JOB DESCRIPTION:

The residential electrician is concerned with wiring new construction and rewiring or adding to existing structures. A journeyman electrician's card from the IBEW Local is often required.

The residential electrician installs all the wiring required in a residence from meter box to fixture, appliance or outlet. He installs meter boxes, distribution panels, electrical boxes, etc. He hangs fixtures, sets appliances and sometimes must decide how to mount and/or attach heavy electrical appliances. He must be able to wire and connect a wide variety of electrical fixtures, appliances, pumps, furnaces, air conditioners, thermostats, door bells, security systems, etc.

CREDIT: Dale Huber, City Electrician, Urbana, Illinois.
Richard Burritt, Caterpillar, Peoria, Illinois.

Residential Electrician

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2.	Calculate voltage, current and power.	0.14.a
3.	Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a
4.	Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
5.	Identify ampacity for common sizes of residential wiring (#14, 12, 8 & 6).	I.12
6.	Divide the electrical load of a residence into the correct number and type of circuits.	I.12
7.	Estimate the total electrical load of a residence.	0.14.a, I.12
8.	Select and install interior wiring including: open wiring, rigid conduit, flexible conduit, armored cable, nonmetallic-sheathed cable, and entrance cable.	I.13.a
9.	Identify and install common wiring materials and devices: insulators; receptacles; plugs; boxes and covers--outlet, utility, sectional, pull boxes; box clamps; plates; strapes, etc.	I.61, I.13.a, 0.16
10.	Wire entrance panel and meter box.	I.13.a
11.	Rewire older existing residences.	I.45
12.	Mount outlet boxes in or on existing wallboard, plaster, brick or concrete walls.	I.13.a, I.45
13.	Install wire in existing walls, attics, basements, crawl spaces, etc.	I.13.a, I.45
14.	Size each circuit with the proper circuit breaker or fuse.	I.14
15.	Identify and install standard switches, fuses, circuit breakers, and thermal cutout/overloads.	I.14
16.	Wire 110V and 220V circuits: light circuits, outlet circuits, appliance circuits, electric heating circuits, switch circuits, furnace circuits, pump circuits, air conditioning.	I.15, 0.50
17.	Wire low voltage circuits including: door bell, intercom, alarm, heating control.	I.15
18.	Install electrical fixtures and wire circuits as indicated by the blueprint: 110V outlets, 2-way switches, 3-way switches, 220V outlets, lighting fixtures, baseboard heaters, radiant heating, intercom, door bells, alarms.	I.15
19.	Use the basic tools and devices needed to wire or connect the circuits as indicated in the blueprint: hammer, screwdriver, electric drill, long nose plier, dykes, tape, solderless connectors, terminals, solder joints.	0.13.a
20.	Use basic measuring and testing instruments, including voltmeter, ammeter, ohmmeter, megger, voltage testers.	I.19.a, I.19.b
21.	Troubleshoot basic circuits to identify faulty wiring or electrical fixtures.	I.20.a
22.	Properly use cleaners and lubricants.	I.25
23.	Explain problem and corrective measures to customer and/or supervisor.	0.80

NOTE:	In the metropolitan areas the electrician must be able to cut, bend, install, etc. conduit.	I.13.b, 0.13.b

RECOMMENDED SEQUENCE OF BLOCKS:

NUMBER	I10	014a	016	I61	I11a	I12	I25	013a	050	I19a	I19b	I13a
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JOB TITLE Agricultural Electrician DOT # 824.281

USOE # 01.0307

EMPLOYING INDUSTRIES Electrical Contractors, Self Employment

JOB DESCRIPTION:

The rural electrician is concerned with wiring new construction and rewiring or adding to existing structures.

The rural electrician installs all the wiring required on a farm and in a residence from meter pole to various buildings and to fixture outlet and all electrical applications on the farm. He installs meter boxes, distribution and entrance panels, electrical boxes, overheat wiring meter loops, etc. He hangs fixtures, sets appliances and sometimes must decide how to mount and/or attach heavy electrical appliances. He must be able to wire and connect a wide variety of electrical fixtures, appliances, pumps, furnaces, air conditioners, thermostats, door bells, security systems, various large motor applications (grain driers, conveyors, hammer mills, ventilation fans, refrigeration units and others), etc.

CREDIT: E. F. Olver, University of Illinois, Agricultural Engineering Department and Executive Secretary, Illinois Farm Electrification Council, Urbana, Illinois.

Agricultural Electrician

SPECIFIC SKILLS REQUIRED:

	SPECIFIC SKILLS REQUIRED	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2.	Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
3.	Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature to include recognition of ANSI symbols used in controls.	I.11.a, I.11.c, 0.17
4.	Identify ampacity for common sizes of residential wiring (#14, 12, 8 & 6).	I.12
5.	Estimate the total electrical load of a residence and farmstead.	0.14.a, I.12
6.	Divide the electrical load of a residence and farmstead into the correct number and type of circuits.	I.12
7.	Size each circuit with the proper circuit breaker or fuse.	I.14
8.	Select and install interior and exterior wiring including: open wiring, rigid conduit, flexible conduit, armored cable, nonmetallic sheathed cable, and entrance cable.	I.13.a, I.13.b, 0.13.b
9.	Identify and install common wiring materials and devices: insulators; receptacles; plugs; boxes and covers--outlet, utility, sectional, pull boxes; box clamps; plates; strapes, etc.	I.61, I.13.b, 0.16
10.	Identify and install standard switches, fuses, circuit breakers, thermal cutout/overloads and ground fault interupters.	I.14
11.	Wire 120V and 240V circuits: light circuits, outlet circuits, appliance circuits, electric heating circuits, switch circuits, furnace circuits, pump circuits, air conditioning, and other motor circuits.	0.15, I.15, 0.50
12.	Wire low voltage circuits including: door bell, intercom, alarm, heating control.	I.15
13.	Install electrical fixtures and wire circuits as indicated by the blueprint: 120V outlets, 2-way switches, 3-way switches, 240V outlets, lighting fixtures, baseboard heaters, radiant heating, intercom, door bells, alarms.	I.15
14.	Use the basic tools and devices needed to wire or connect the circuits as indicated in the blueprint: hammer, screwdriver, electric drill, long nose pliers, dykes, tape, solderless connectors, terminals, solder joints.	0.13.a
15.	Wire entrance panel including channels and meter box.	I.13.a
16.	Troubleshoot basic circuits to identify faulty wiring, electrical fixtures, and motor problems (including motor overloads).	I.20.a
17.	Use basic measuring and testing instruments, including voltmeter, ammeter, ohmmeter, meggar, voltage testers, wattmeter, oscilloscope.	I.19.a, I.19.b
18.	Rewire older existing residences and farmsteads.	I.45
19.	Mount outlet boxes in or on existing wallboard, plaster, brick or concrete walls.	I.13.a
20.	Install wire in existing walls, attics, basements, crawl spaces, etc.	I.13.a, I.45
21.	Install typical three phase systems on farms (wye & delta).	I.13.a
22.	Install underground wiring (joints, coupling, sealing, drainage).	I.13.b
23.	Install waterproof wiring systems in animal environments where moisture is a problem using all procedures to minimize corrosion problems in boxes where the wiring connections are made.	I.13.b

	EDUCATIONAL BLOCKS REQUIRED
24. Properly use cleaners and lubricants.	I.25
25. Calculate voltage, current and power.	0.14.a
26. Install, connect and maintain AC motors and alternators.	I.18
27. Install, connect and maintain industrial control equipment.	I.34
28. Properly rig and move heavy equipment.	I.21
29. Properly perform both arc and oxycelylene welding as needed according to welding society codes.	I.24

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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NUMBER	I25											
PAGE												

JOB TITLE Commercial Electrician (Construction) DOT # 824.281-014

USOE # 17.1002

EMPLOYING INDUSTRIES

JOB DESCRIPTION:

Commercial electricians perform tasks involved in wiring new or existing commercial structures. A journeyman card from an IBEW Local is often required. He installs service entrances and all circuits from load to switch. He makes all cable connections and terminal points to insure proper load and operation. He mounts electrical equipment, boxes, switches, heaters, motors, fans, controls, etc. He uses common hand and power tools to aid in the installation of electrical hardware and equipment.

CREDIT: Dale Huber, City Electrician, Urbana, Illinois.
Roy Klevin, Electrical Contractor, Cisco, Illinois.
Richard Burritt, Caterpillar, Peoria, Illinois.
Kraft Foods Training Program, Champaign, Illinois.

Commercial Electrician (Construction)

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2.	Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
3.	Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.c
4.	Select, install interior wiring including: open wiring, rigid conduit, flexible conduit, liquid tight flexible conduit, armored cable, metal raceways, nonmetallic-sheathed cable, entrance cable, under-floor raceways, wireways, bus ways.	0.16, I.13.a, I.13.b
5.	Install underground wiring systems: joints, coupling, sealing, drainage.	I.13.b
6.	Identify and install common wiring materials and devices: insulators; receptacles; plugs; boxes and covers--outlet, utility, sectional, floor, pull boxes; box clamps; plates; strapes, etc.	I.61, I.15
7.	Identify and install standard switches, fuses, circuit breakers, and thermal cutout/overloads.	I.14
8.	Select and install wire, cable and bus materials on the basis of voltage, current and temperature according to codes.	I.12
9.	Hook up basic electric circuits: series, shunt, series parallel, feeder main, branch, tap distribution center, direct radial, radial group tree, loop, (including DC, single and three phase) using basic joints and connectors.	0.50, I.15, 0.15
10.	Identify and install single and three phase transformer and capacitors including boost buck.	I.16
11.	Install, connect and maintain DC motors and generators.	I.17
12.	Install, connect and maintain AC motors and alternators.	I.18
13.	Install and connect industrial control equipment (electrical, electronic, electromechanical and magnetic).	I.34
14.	Rewire or modify existing wiring systems.	I.45
15.	Calculate voltage, current, power, impedance and power factor.	0.14.a, 0.14.b
16.	Install and connect common industrial electronic devices, circuits, and systems (power supplies, rectifiers, transducers, amplifiers, etc.).	0.17, 0.18
17.	Rig for moving heavy loads.	I.21
18.	Use basic measuring and testing instruments: continuity checker (e.g., Megger), voltage testers, voltage indicators, voltmeters, ammeters, VOM, ohmmeters, wattmeter, watt hour meter, scopes.	I.19.a, I.19.b
19.	Use and care for common hand and power tools.	0.13.a
20.	Troubleshoot basic circuits to identify faulty wiring or electrical fixtures.	I.20.a
21.	Properly use cleaners and lubricants.	I.25

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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NUMBER	I19b	I13a	013b	I13b	I45	I14	I15	I16	I17	I18	I34	I20a
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JOB TITLE Industrial Electrician (Construction) DOT # 824.281-014

USOE # 17.1002

EMPLOYING INDUSTRIES

JOB DESCRIPTION:

Electricians perform tasks involved in wiring new or existing industrial buildings, manufacturing plants, etc.

The electrician installs all wiring required in conduit, raceways and cable ways from distribution centers to electrical load. He installs conduit, junction boxes, circuit breakers, starters, etc. He hangs or mounts and connects electrical loads, including lighting, motors, etc. He uses common hand and power tools to aid in the installation of electrical hardware and equipment. He installs electrical service from power company interface to main breakers.

The main difference between commercial and industrial jobs would be the physical size and electrical capacity of the tools, hardware and equipment involved. Also special jobs based upon unique circumstances such as: explosive atmosphere, clean rooms and other excessive environmental conditions.

CREDIT: Dale Huber, City Electrician, Urbana, Illinois.
Roy Klevin, Electrical Contractor, Cisco, Illinois.
Richard Burritt, Caterpillar, Peoria, Illinois.
Bob Billings, Illinois Power, Champaign, Illinois.

Industrial Electrician (Construction)

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2. Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
3. Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.c
4. Select, install interior wiring including: open wiring, rigid conduit, flexible conduit, liquid tight flexible conduit, armored cable, metal raceways, nonmetallic-sheathed cable, entrance cable, under-floor raceways, wireways, bus ways.	0.16, I.13.a, I.13.b
5. Install underground wiring systems: joints, coupling, sealing, drainage.	I.13.b
6. Identify and install common wiring materials and devices: insulators; receptacles; plugs; boxes and covers--outlet, utility, sectional, floor, pull boxes; box clamps; plates; strapes, etc.	I.61, I.13.a, I.13.b
7. Identify and install standard switches, fuses, circuit breakers, and thermal cutout/overloads.	I.14
8. Select and install wire, cable and bus materials on the basis of voltage, current and temperature according to codes.	I.12
9. Hook up basic electric circuits: series, shunt, series parallel, feeder main, branch, tap distribution center, direct radial, radial group tree, loop, (including DC, single and three phase) using basic joints and connectors.	0.50, I.15, 0.15
10. Identify and install single and three phase transformer and capacitors including boost buck.	I.16
11. Install, connect and maintain DC motors and generators.	I.17
12. Install, connect and maintain AC motors and alternators.	I.18
13. Install and connect industrial control equipment (electrical, electronic, electromechanical and magnetic).	I.34
14. Rewire or modify existing wiring systems.	I.45
15. Calculate voltage, current, power, impedance and power factor.	0.14.a, 0.14.b
16. Properly rig equipment to be moved.	I.21
17. Properly use hand and power tools as well as care for them properly.	0.13.a, 0.13.b
18. Properly use cleaners and lubricants.	I.25
19. Use basic measuring and testing instruments: continuity checker (e.g., Megger), voltage testers, voltage indicators, voltmeters, ammeters, VOM, Ohmmeters, wattmeter, watt hour meter.	I.19.a, I.19.b
20. Install and connect industrial electronic devices, circuits, and systems (power supplies, rectifiers, transducers, amplifiers, etc.)	0.16, 0.17, 0.18
21. Troubleshoot and repair wiring systems, motors, controls, switches and other electrical equipment.	I.20.a

Industrial Electrician (Construction)

RECOMMENDED SCHEDULE OF EDUCATIONAL BLOCKS:

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NUMBER	I21	I25	014b	018	I11b							
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JOB TITLE Industrial Electrician DOT # 825.281

USOE # 17.1401

ALTERNATE TITLES Maintenance Electrician (829.281)

EMPLOYING INDUSTRIES Major Industry

COMMENT: In high school the work should be limited to 500 volts.

JOB DESCRIPTION:

From wiring diagrams and blueprints, assembles, installs and alters power, light, signal and alarm systems in all factory buildings. Constructs, alters and maintains main distribution lines. Builds, installs or services interlocking control circuits and panels used in conjunction with machine tools. Services and repairs the electrical equipment used with heat treat units. Repairs windings for polyphase motors and generators. Installs and wires machine tools.

Installs, and repairs electronic circuits used on machine tools and plant equipment. Tests faulty equipment and applies knowledge of operation of electronic units and systems to diagnose malfunctions. Tests electronic components and circuits to locate defects using instruments such as oscilloscopes, signal generators, electronic counters, recorders, transistor checkers, capacitor checkers, etc. Aligns, balances and calibrates equipment. Calibrates and services electronic testing instruments.

To qualify for this job, employee must satisfactorily demonstrate proficiency in electronic theory and application relating to plant operations and equipment.

CREDIT: Richard Burritt, Caterpillar, Peoria, Illinois.
Kraft Foods Training Program, Champaign, Illinois.
Roy Klevin, Electrical Contractor, Cisco, Illinois.
Ed Fetzer, Illinois Central Railroad, Chicago, Illinois.

Industrial Electrician

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2.	Calculate voltage, current, power, impedance and power factor.	0.14.a, 0.14.b
3.	Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.c
4.	Select, install interior wiring including: open wiring, rigid conduit, flexible conduit, liquid tight flexible conduit, armored cable, metal raceways, nonmetallic sheathed cable, entrance cable, under-floor raceways, wireways, bus ways.	I.13.a, I.13.b
5.	Install underground wiring systems: joints, coupling, sealing, drainage.	I.13.b
6.	Identify and install common wiring materials and devices: insulators; pull boxes; box clamps; plates; strapes, etc.	0.16, I.61, I.13.a, I.13.b
7.	Identify and install standard switches, fuses, circuit breakers, and thermal cutout/overloads.	I.14
8.	Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
9.	Select and install wire, cable and bus materials on the basis of voltage, current and temperature according to codes.	I.12
10.	Hook up basic electric circuits: series, shunt, series parallel, feeder main, branch, tap distribution center, direct radial, radial group tree, loop, (including DC, single and three phase) using basic joints and connectors.	0.50, I.15, 0.15
11.	Rewire or modify existing wiring systems.	I.45
12.	Install, connect and maintain DC motors and generators.	I.17
13.	Install, connect and maintain AC motors and alternators.	I.18
14.	Install, connect and maintain industrial control equipment (electrical, electronic, electromechanical and magnetic).	I.34
15.	Identify and install single and three phase transformer and capacitors including boost buck.	I.16
16.	Use basic measuring and testing instruments: continuity checker (e.g., Megger), voltage testers, voltage indicators, voltmeters, ammeters, VOM. Ohmmeters, wattmeter, watt hour meter, scopes.	I.19.a, I.19.b
17.	Troubleshoot and repair wiring systems, motors, controls, switches and other electrical equipment.	I.20.a
18.	Install, connect, troubleshoot and repair common industrial electronic devices, circuits, and systems (power supplies, rectifiers, transducers, amplifiers, etc.).	0.17, 0.18, I.11.b, 0.20.a, I.20.b, 0.20.b, 0.19.a
19.	Exhibit related skills including rigging, handtools, power tools, etc., their selection, care and use.	I.21, 0.13.a, 0.13.b, 0.13.c
20.	Properly use cleaners and lubricants.	I.25
21.	Properly perform both arc and oxyacetylene welding as needed according to welding society codes.	I.24

RECOMMENDED SCHEDULE OF EDUCATIONAL BLOCKS:

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JOB TITLE Locomotive Electrician DOT # 825.281-034

USOE # 17.14

EMPLOYING INDUSTRIES All Railroads

COMMENT: In high school the work should be limited to 500 volts.

JOB DESCRIPTION:

From wiring diagrams and blueprints, assembles, installs and alters power, light, signal and alarm systems in locomotives. Constructs, alters and maintains locomotive equipment. Builds, installs or services interlocking control circuits and panels used in conjunction with locomotive circuits. Repairs windings for polyphase motors and generators.

Installs and repairs locomotive electronic circuits and equipment. Tests electronic components and circuits to locate defects using instruments such as oscilloscopes, signal generators, electronic counters, recorders, transistor checkers, capacitor checkers, etc. Aligns, balances, and calibrates equipment. Calibrates and services electronic testing instruments.

Performs periodic maintenance inspection and does numerous checks to insure the locomotive is in good working order. Tests and adjusts locomotive circuits.

Performs various tests and checks to insure proper operation and to diagnose malfunctions.

Performs various adjustments to insure proper operation of locomotive circuits.

CREDIT: Ed Fetzer, Illinois Central Railroad, Chicago, Illinois.
Richard Burritt, Caterpillar, Peoria, Illinois.
Kraft Foods Training Program, Champaign, Illinois.
Roy Klevin, Electrical Contractor, Cisco, Illinois

Locomotive Electrician

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards	I.10
2.	Locate, read and follow the applicable provisions of local, state and national electrical codes.	I.12
3.	Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.c, 0.17
4.	Select and install wire, cable and bus materials on the basis of voltage, current and temperature according to codes.	I.12
5.	Select and install locomotive wiring including: open wiring, rigid conduit, flexible conduit, liquid tight flexible conduit, armored cable, nonmetallic sheathed cable, and under-floor raceways.	I.13.a, I.13.b, 0.13.b
6.	Identify and install common wiring materials and devices: insulators; receptacles; plugs; boxes and covers--outlet, utility, sectional, floor, pull boxes; box clamps; plates; strapes, etc.	0.16, I.61, I.13.a, I.13.b
7.	Identify and install standard switches, fuses, circuit breakers, and thermal cutout/overloads.	I.14
8.	Hook up basic electric circuits: series, shunt, series parallel, feeder main and (including DC, single and three phase) using basic joints and connectors.	I.15, 0.15, 0.50
9.	Identify and install single and three phase transformers and capacitors including boost buck.	I.16
10.	Install, connect, and maintain DC motors and generators.	I.17
11.	Install, connect and maintain AC motors and alternators.	I.18
12.	Install, connect and maintain industrial control equipment (electrical, electronic, electromechanical and magnetic).	I.34
13.	Calculate voltage, current, power, impedance and power factor.	0.14.a, 0.14.b
14.	Install, connect, troubleshoot and repair common locomotive electronic devices, circuits, and systems (power supplies, rectifiers, transducers, amplifiers, etc.).	0.18, I.11.b, 0.20.a, I.20.b, I.22
15.	Properly rig for moving heavy loads.	I.21
16.	Use basic measuring and testing instruments: continuity checker (e.g., Megger), voltage testers, voltage indicators, voltmeters, ammeters, VOM, Ohmmeters, wattmeter, watt hour meter, scopes.	I.19.a, I.19.b
17.	Troubleshoot and repair wiring systems, motors, controls, switches and other electrical equipment.	I.22
18.	Install, connect and repair high voltage, low voltage and car body circuits.	I.22
19.	Perform visual and periodic inspections.	I.22
20.	Use and care for common hand and power tools.	0.13.a, 0.13.c
21.	Test, check, repair and overhaul generator, motor and batteries.	I.22
22.	Properly use cleaners and lubricants.	I.25
23.	Install, maintain and repair refrigeration equipment.	I.63

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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JOB TITLE Electrical Technician DOT # 003.181-010

USOE # 16.0102

ALTERNATE TITLES Electric - Laboratory Technician

EMPLOYING INDUSTRIES

JOB DESCRIPTION:

Applies electrical theory and related subjects to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories. Assembles and tests experimental electrical equipment and components, according to engineering data and knowledge of electrical principles. Modifies electrical prototypes to correct functional deviations under direction of electrical engineer. Diagnoses cause of electrical or mechanical malfunction or failure of operational equipment and performs preventive and corrective maintenance. Develops wiring diagrams, lay-out drawings, and engineering specifications for system or equipment modifications or expansion, and directs personnel performing routine installation and maintenance duties. Plans, directs, and records periodic electrical testing, and recommends or initiates modification or replacement of equipment which fails to meet acceptable operating standards.

CREDIT: Advisory Committee

Electrical Technician

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.c, I.11.a, I.11.b
3. Locate, read and follow the applicable provisions of local, state and national electrical code.	I.12
4. Install common wiring systems.	I.13.a, I.13.b
5. Install common wiring material.	0.13.b
6. Install underground wiring systems.	I.13.b
7. Overhaul, rebuild and repair rotating electrical devices.	I.23
8. Install, connect and maintain DC motors and generators.	I.17
9. Install, connect and maintain AC motors and alternators.	I.18
10. Install and connect industrial controls.	I.34
11. Define basic electrical parameters, their characteristics, units and inter-relationships in circuits containing resistors, capacitors and inductors.	0.14.a, 0.14.b
12. Demonstrate knowledge of circuits, series, parallel and series-parallel by determining unknown parameters.	0.15
13. Identify electrical and electronic components by their physical characteristics, schematic symbol, color coding or printed specifications.	0.16, I.61, I.62
14. Demonstrate knowledge of the functions and applications of common circuit components.	0.17
15. Identify the primary functions and applications of common electronic circuits.	0.18
16. Properly use and employ VOM's, VTVM's, clamp-on meters and oscilloscope.	I.19.a, I.19.b
17. Locate and identify common faults of electronic circuits and components typically found in electronic systems.	I.20.a, 0.20.b, 0.20.a, I.20.b
18. Properly use common hand and power tools.	0.13.a, 0.13.c
19. Properly use cleaners and lubricants.	I.25
20. Properly install and remove electrical/electronic components employing suitable soldering tools and techniques.	I.50
21. Select, install and connect switches and fuse and circuit breaker panels.	I.14
22. Connect basic electrical circuits.	I.15
23. Install and maintain capacitors and transformers.	I.16
24. Keep clear and concise records of work performed and communicate this information to others using conventional methods and form.	0.26

NOTE: This occupation requires post-high school education for entry level employment. However, the following sequence, in conjunction with math and science courses will make transfer to the post-high school institution much smoother, even permitting advanced standing in many cases.

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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JOB TITLE Electric Motor Repairman DOT # 721.281

USOE # 17.1403

ALTERNATE TITLES Electric Motor Analyst (721.281), Tear Down Man, Electric Motor Winder (721.884), Electric Motor Tester (721.281)

EMPLOYING INDUSTRIES

JOB DESCRIPTION:

Assembles, tests and repairs electric motors, generators and starters. Cleans and repairs or replaces damaged parts. Makes measurements and adjusts to name plate data. Rewinds armature, starters and field windings. Replaces defective parts such as brushes, cables and connecting wires. Tests armature and starter for shorts, grounds or broken wires. Examines bearings and shafts for wear. Replaces bearings, shafts, fans, switches and capacitors.

CREDIT: Doran Hershberger, General Electric, DeKalb, Illinois.

Electric Motor Repairman

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Wear appropriate safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret mechanical and electrical diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, 0.16, 0.17, I.11.c
3. Identify type and phase of motors and generators including single phase, three phase and DC.	I.23
4. Identify machine components by physical characteristics, color codes, etc., including stator, rotor, field winding, brushes, commutator switches, bearings, shafts, capacitors and thermal overloads.	I.23
5. Connect motor or wire motor according to name plate.	I.17, I.18
6. Use common test equipment including meggar, VOM, growler, bearing puller and driver, amp pole and test light.	I.19.a, I.23, I.19.b
7. Check, reoil or replace bearings.	I.17, I.18
8. Replace brushes.	I.17, I.18
9. Replace or adjust switches.	I.17, I.18
10. Rewind stator, rotor and field windings.	I.23
11. Troubleshoot and repair or replace faulty winding or part.	I.17, I.18, I.23
12. Test pole-piece polarities.	I.17, I.18, I.23
13. Use and care for common hand and power tools.	0.13.a
14. Exhibit related skills, i.e., rigging and hoists.	I.21
15. Identify and connect industrial control equipment.	I.34, I.14,
16. Properly use cleaners and lubricants.	I.25
17. Calculate current, voltage, power, impedance and power factor.	0.14.a, 0.14.b
18. Properly install and remove electrical/electronic components employing suitable soldering tools and techniques.	0.50
19. Keep clear and concise records of work performed.	0.26

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	014a	016	017	I11a	I11c	013a	050	I19a	I19b	I14	I17
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PAGE	3-54	3-56	3-62	3-28	3-66	3-100	3-112					

JOB TITLE Lineman (Communications) DOT # 822.381-026

USOE # 17.1402

EMPLOYING INDUSTRIES Telephone Company, Cable T.V., Railroads

JOB DESCRIPTION:

Installs, connects, maintains, rearranges, and dismantles aerial, buried, building or underground telephone plant and associated wiring and cable, including poles. Frequently performs work on poles or uses bucket trucks. Uses light and heavy machinery such as compressors, trenchers, etc.

Assists in the connection, removal and relocation of cable facilities that provide service between central office and customer premises. Works on all types of cable in manholes, trenches and on poles and ladders. Uses hand tools and electrical equipment. Performs job duties as directed by the Cable Splicer. Wears safety glasses, other safety equipment and follows established safety procedures. Drives company vehicle. Performs other duties comparable to the above as assigned. Must be willing to work any shift, overtime, weekends or holidays.

CREDIT: Roy Stonehocker, ATT Long Lines, Springfield, Illinois.
Illinois Bell Telephone Company (Job Description), Chicago, Illinois.
ATT Long Lines (Job Description TG-2), Chicago, Illinois.

Lineman (Communications)

	SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and following established safety practices, procedures, and OSHA Standards.	I.10
2.	Work with heavy duty power equipment and hand tools in the installation, repair, and maintenance of outside plant facilities.	OJT
3.	Load necessary tools and equipment onto truck or trailer.	I.51, I.53
4.	Drive company truck to work location.	OJT
5.	Climb poles, enter tunnels, buildings, trenches, crawl spaces or manholes to place materials.	I.51
6.	Operate power equipment such as compressors, pumps, blowers and hydraulic aerial lifts mounted on trucks.	OJT
7.	Dig holes.	I.51
8.	Place poles.	I.51
9.	Lay cable and conduit in ground	I.51
10.	Unreel and string wire and cable from pole to pole.	I.51
11.	Connect wire and cables to terminals.	I.51
12.	Attach or detach various kinds of hardware to wires, cables, buildings, or poles.	I.51
13.	Use test equipment to check for gas in manholes.	I.51
14.	Empty water and other debris from manholes.	OJT
15.	Dismantle, move or remove, aerial, underground or building wire and associated equipment and hardware.	OJT
16.	Read and interpret drawings and specifications in order to complete work orders.	I.11.a, I.11.c, O.16, O.17
17.	Follow company practices and procedures.	OJT
18.	Define basic electrical parameters, their characteristics, units and inter-relationships.	O.14.a
19.	Properly use cleaners and lubricants.	I.25
20.	Properly use VOM, VTVM's, meggars, high voltage bridges, oscilloscopes, etc.	I.19.a, I.19.b
21.	Use common hand and power tools properly.	O.13.a
22.	Properly solder using suitable soldering equipment and techniques.	O.50

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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NUMBER	I53											
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JOB TITLE Lineman, Journeyman (Power Industry) DOT # 822.281-010

USOE # 17.1402

ALTERNATE TITLES Cableman, Cable Splicer, Substation Electrician, Underground Repairman

EMPLOYING INDUSTRIES Electric Utilities, Transmission Line Contractors, Outside Electrical Contractors

JOB DESCRIPTION:

Installs rigging necessary to set poles and towers and strings wires over hills and rough countryside. Digs holes and trenches for poles and underground electrical systems. Puts a 500 foot steel tower together, erects it, and then climbs it and puts the wires in place. Handles energized wires from 120 to 345,000 volts. Must know basic electrical theory. Strings wires, splices, and sags according to basic charts. Knows transformers, and makes all connections for three phase banks. Knows principles of street lighting, both multiple and series. Knows operating equipment for installing underground wires and conduits. Is familiar with laying concrete encased conduits, installing manholes and transformer vaults. Is able to pull high voltage wires in conduits and make all necessary submersible splices.

Must know how to handle all tools of the trade and know all safety procedures for working with and around energized lines. Must know first-aid, mouth-to-mouth top resuscitation, and pole top rescues.

CREDIT: O. Welker, Jr., Business Manager, IBEW Local 50, Champaign, Illinois.
R. A. Billing, Albat Instructor, Champaign, Illinois.
Chronical Guidance Occupation Brief #109.

Lineman, Journeyman (Power Industry)

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely, using proper safety equipment and following established safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret drawings and specs in order to work and complete assignments.	I.11.a
3. Use tools and work equipment properly.	I.53, O.13.a
4. Read instruction books, maintenance manuals on electrical equipment installed on power lines and in substations.	I.11.a
5. Handle poles safely.	I.51
6. Dig pole holes.	I.51
7. Frame poles.	I.51
8. Install anchors.	I.51
9. Climb poles.	I.51
10. Install crossarms.	I.51
11. Tie in conductors.	I.51
12. Install protective grounds.	I.51
13. Perform pole top rescues.	I.51
14. Use safety blankets properly.	I.10
15. Splice conductors using compression and sleeve splices.	I.51
16. Install meters.	I.27
17. Install service.	I.27
18. Properly ground trucks.	OJT
19. Correct sagging conductors.	OJT
20. Connect transformers.	I.51
21. Connect lighting arrestors.	I.51
22. Connect switches.	I.51
23. Connect regulators.	I.51
24. Energize and de-energize lines.	I.51
25. Test for polarity.	I.51
26. Use transits.	I.51
27. Operate substations.	I.51
28. Move energized lines.	OJT
29. Define basic electrical parameters, their characteristics, units and inter-relationships.	O.14.a
30. Properly use cleaners and lubricants.	I.25
31. Properly use VOM's and clamp-on meters.	I.19.a
32. Identify common equipment used in the electric utility industry and its function and/or application.	I.62

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	O14a	I62	I11a	O13a	I19a	I25	I51	I53	I27		
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JOB TITLE Troubleman DOT # 821.281-026

USOE # 17.140

ALTERNATE TITLES Lineman, Underground Repairman

EMPLOYING INDUSTRIES Electric Utilities

JOB DESCRIPTION:

As a rule, a troubleman works alone, assigned to maintain good electric service in a designated area. He should be able to locate and correct all problems on primary and secondary circuits. Run services and set meters. Collects overdue bills. Repair street lights and street light circuits. Operate substations and its equipment. Operate switching on high voltage lines.

Must have several years experience as a lineman. Must be able to work safely and diligently alone. Must be mechanically inclined in the use and care of tools.

CREDIT: R. A. Billing, Illinois Power Company, Champaign, Illinois.

Troubleman

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow safety practices, procedures and OSHA Standards.	I.10
2. Identify electrical components and equipment by their physical characteristics.	O.16, I.62
3. Locate and read instruction books and MTCE manuals on electrical equipment installed on power lines and in substations.	I.11.a, I.11.c
4. Climb poles.	I.51
5. Install protective grounds.	I.51
6. Use safety blankets properly.	I.10
7. Splice conductors.	I.51
8. Install meters.	I.27
9. Install service.	I.27
10. Energize and de-energize lines.	I.51
11. Operate substations.	I.51
12. Operate street lights and their circuits.	I.51
13. Do switching on high voltage lines.	I.51
14. Locate and correct trouble on primary and secondary circuits.	I.51, O.17, O.15
15. Use and care for common hand, power, and lineman tools.	O.13.a, I.53
16. Define basic electrical parameters, their characteristics, units and relationships.	O.14.a
17. Define the electrical parameters in circuits containing capacitors, inductors and transformers.	O.14.b
18. Properly use common electrical test instruments.	I.19.a, I.19.b
19. Properly use cleaners and lubricants.	I.25

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	O14a	O16	O17	O15	I62	I11a	I11c	O13a	I19a	I19b	I25
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JOB TITLE Electric Meterman, Repairman, Tester DOT # 729.231

USOE # 17.1401

ALTERNATE TITLES Meterman (729.231), Meter Repairman (710.281), Meter Testers

EMPLOYING INDUSTRIES Electric Utilities, Large Industries, Meter Manufacturers

JOB DESCRIPTION:

He must have a good background in math, know vectors, be skilled in bench testing, know how to use electronic calculators.

He will be required to be familiar with all manufacturer's meters, both single and polyphase. Be able to internally wire meter cabinets, know use of current and potential transformers. Know magnetic-tape metering. Test and adjust all single and polyphase meters.

CREDIT: R. A. Billing, Illinois Power Company, Champaign, Illinois.

Electric Meterman, Repairman, Tester

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret electrical equipment drawings, schematics and wiring diagrams and manufacturer's manuals and literature.	I.11.a, I.11.c
3. Identify electrical components and equipment by their physical characteristics.	0.16, I.62
4. Calculate current, voltage, impedance and power.	0.14.a, 0.14.b
5. Install single and polyphase meters.	I.27
6. Install, connect and read time recordings of voltage, current and power.	I.31
7. Perform those skills peculiar to the electric meter repairman: a. prewire single and polyphase meter cabinets. b. know principles of current and potential transformer. c. ratio check of current and potential transformer. d. adjust meters. e. repair all makes of meters. f. make connections between current and potential transformers and metering cabinet.	I.32
8. Use and care for common hand and power tools.	0.13.a
9. Identify and troubleshoot basic metering circuits.	I.20.a, I.32
10. Use multimeters and current probes.	I.19.a, I.19.b
11. Properly use cleaners and lubricants.	I.25
12. Keep clear and concise records of work performed.	0.26

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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JOB TITLE Meter Installer DOT # 821.381-002

USOE # 17.1401

EMPLOYING INDUSTRIES Electric Utilities, Large Industries

JOB DESCRIPTION:

Have knowledge of single and polyphase meters and their installation. Be able to make minor test for proper operation. Be able to read meter registers and change linear paper charts. Installs and removes electric watt-hour meters. Installs and removes recording meters. Sets meters to time of day. Installs current meters and makes connections to current meter. Must be able to work safely and diligently alone.

CREDIT: R. A. Billing, Illinois Power Company, Champaign, Illinois.

Meter Installer

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely using proper safety equipment and follow established safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret wiring diagrams, schematics, blueprints and manufacturer's manuals and literature.	I.11.a, I.11.c
3. Identify electrical components by their physical characteristics.	0.16, I.62
4. Install, connect and read time recordings of voltage, current and power.	I.31
a. read registers and charts.	
b. change chart meters.	
5. Install single and polyphase meters.	I.27
a. perform pre-installation tests.	
1) cross check meter and meter base.	
2) check voltage.	
6. Use and care for common hand and power tools.	0.13.a
7. Properly use cleaners and lubricants.	I.25
8. Use multimeters and clamp-on meters.	I.19.a
9. Define basic electrical parameters, their characteristics, units and relationship.	0.14.a

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

NUMBER	I10	014a	016	I62	I11a	I11c	013a	I19a	I25	I27	I31	
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JOB TITLE Electrolysis Tester

DOT # 821.381-030

USOE # 17.1403

ALTERNATE TITLES Cathodic Protection Technician

EMPLOYING INDUSTRIES Power Companies, Gasline Companies, Utilities, Phone Companies

JOB DESCRIPTION:

Performs tests and makes electrical measurements of corrosion and electrolysis conditions of cables, tanks, pipes and cathodic electrolysis protection installations in manholes, ducts, and substations. Performs tests of the negative return circuits of power distribution systems to accumulate test data for analysis.

Responsible for properly performing tests and accurately reading and recording the results. Responsible for properly operating and carefully handling considerable amounts of expensive electrical measuring equipment. Responsible for exercising care to avoid electric shock or burns when working in close proximity to energized 600 volt conductors. Responsible for preparing accurate sketches of cable, duct, and manhole layouts and testing procedures. Responsible for promptly reporting any defective conditions of the electrical distribution system.

Must have considerable understanding of the basic fundamentals of electricity. Must be able to read and interpret readings of voltmeters, ammeters, 24 hour voltage recorders, half-cells, etc. Must have reasonable knowledge of the theory of electrolysis and of the cathodic electrolysis protection plants. Must have reasonable knowledge of electrical distribution systems and substation electrical drainage systems. Must have reasonable knowledge of cable types and sizes and bondings.

CREDIT: Chicago Transit Authority Job Description (Schedule #E-2266, Grade #1 - BEW 134), Chicago, Illinois.

Electrolysis Tester

SPECIFIC SKILLS REQUIRED:	EDUCATIONAL BLOCKS REQUIRED
1. Work safely, using proper safety equipment and following established safety practices, procedures and OSHA Standards.	I.10
2. Read and interpret drawings and specs in order to work and complete assignments.	I.11.a, I.11.c, 0.15
3. Load necessary tools and equipment onto truck or trailer.	OJT
4. Drive company truck to work location.	OJT
5. Perform electrolysis tests on cables, tanks, pipes and cathodic protection installations in manholes, ducts, substations and garages.	I.60
6. Locate from drawings cables, pipes or taps of cathodic protection installations.	I.60
7. Set up proper electrical measurement equipment and connect it properly, as well as properly read and record measurements: a. high and low resistance volt meters. b. direct current ammeters. c. one- and four-rod soil resistance measuring instruments. d. 24-hour voltage recording instruments. e. copper sulfate half cells. f. directional current ammeters.	I.60
8. Determine type, amount and direction of voltage and absistance to flow of current.	0.14.a
9. Collect and properly label samples of soil and corrosion products for analysis.	I.60
10. Perform tests of negative return circuits of power distribution systems to accumulate test data for analysis.	OJT OJT
11. Locate trolley laterals, substation getaways, rail taps, etc., and determine proper placement and set-up of measuring equipment.	I.60
12. Make tests of wood strain insulators and trolley line hangers.	OJT
13. Utilize testing equipment to obtain and record test data relating to the condition of non-lead sheathed positive cables of power distribution systems.	OJT
14. Prepare simple diagrams showing methods of performing tests and locations of cables, tanks, pipes, and taps of cathodic protection plants.	I.11.a
15. Prepare simple longhand reports explaining test procedures followed, readings obtained and duct layouts of substations and manholes.	I.11.a
16. Participate in electrolysis tests with other utilities with proximity to company cables and pipes.	OJT, I.19.a, I.19.b
17. Make visual inspection of cables, ducts, bondings, and manholes and report on condition.	OJT
18. Properly use cleaners and lubricants.	I.25
19. Properly use common hand and power tools.	0.13.a
20. Identify common components in current use.	0.16
21. Identify the function and application of common components.	0.17
22. Properly perform suitable soldering techniques using suitable tools.	0.50

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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JOB TITLE Lighting Director

DOT # 824.884

USOE # 16.0108

ALTERNATE TITLES Stage Electrician (17.1002), Studio Electrician

EMPLOYING INDUSTRIES Theatres, Performing Arts

JOB DESCRIPTION:

From the script, the director and rehearsals, the lighting director determines the lighting requirements. He hangs, sets up and installs the right Gel in the spots. He works with stage lighting and house lighting. He must properly place stage lighting to achieve the desired effect. He must patch the lighting panel. He must operate the lighting board and set up the pre-set dimmers and operate the remaining dimmers on cues from the director and script. He must make all installations and work in compliance with OSHA Standards and the electrical codes. He must keep all lighting systems in repair and good operating order. He must work well with people and have an appreciation of the performing arts. He must at times work in cramped quarters and at heights.

CREDIT: W. Nash, Building Supervisor, Krannert Center, University of Illinois,
Urbana, Illinois.

Lighting Director

SPECIFIC SKILLS REQUIRED:		EDUCATIONAL BLOCKS REQUIRED
1.	Work safely using proper safety equipment and following established safety practices, procedures and OSHA Standards.	I.10
2.	Locate, read and follow applicable provisions of local, state and national electrical codes.	I.12
3.	Read electrical/electronic equipment drawings, diagrams and schematics and manufacturer's manuals and literature.	I.11.a, I.11.c
4.	Identify electrical wiring and electrical/electronic lighting equipment components and systems by physical characteristics, color codes, etc.	0.17, 0.16, I.61
5.	Calculate current, voltage, resistance, power and individual and total circuit capacity.	0.14.a, 0.14.b
6.	Identify and troubleshoot lighting systems including stage manager's console, house and stage lighting and patch panels.	I.20.a, I.33
7.	Identify, troubleshoot and repair common electrical/electronic lighting equipment circuits including single and three phase lighting circuits, spotlights, switches, timers, fans, electronic dimmers, patch panels and lighting consoles.	I.33, 0.20.a, I.20.b, I.11.b
8.	Use and care for multimeters, light meters and ohm meters.	I.19.a, I.19.b
9.	Use and care for common hand and power tools.	0.13.a, 0.13.c
10.	Demonstrate knowledge of series, parallel, series-parallel circuits and three phase lighting circuits.	0.15
11.	Install, remove and transport bulky and heavy lighting equipment.	I.21
12.	Properly use cleaners and lubricants.	I.25
13.	Identify the primary functions and applications of common electronic lighting systems.	0.18

RECOMMENDED SEQUENCE OF EDUCATIONAL BLOCKS:

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CROSS REFERENCE CHART
OCCUPATIONS / EDUCATIONAL BLOCK

EDUCATIONAL BLOCKS

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ELECTRICAL APPLIANCE SET-UP MAN	X	X	X					X	X	X	X	X		X						X							X
ELECTRIC APPLIANCE SERVICEMAN	X	X	X	X				X	X	X	X	X	X	X	X	X			X	X	X			X	X	X	
ELECTRIC APPLIANCE REPAIRMAN	X	X	X	X	X			X			X	X	X	X										X		X	
ELECTRICIAN – RESIDENTIAL	X	X	X			X		X		X	X	X	X	X	X	X	X	X	X	X	X					X	
ELECTRICIAN – AGRICULTURAL ELECTRIFICATION	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X
ELECTRICIAN – COMMERCIAL CONSTRUCTION	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ELECTRICIAN – INDUSTRIAL CONSTRUCTION	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
INDUSTRIAL ELECTRICIAN	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ELECTRICIAN – LOCOMOTIVE	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X
ELECTRICAL TECHNICIAN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
ELECTRIC MOTOR REPAIRMAN	X	X	X	X				X	X		X	X	X	X	X					X			X	X	X		X
LINEMAN (COMMUNICATIONS INDUSTRY)	X	X	X	X				X	X		X	X	X	X	X												
LINEMAN (POWER INDUSTRY)	X	X					X	X			X	X		X													
TROUBLEMAN	X	X	X	X	X		X	X	X		X	X		X	X												
METER REPAIRMAN	X	X	X				X	X	X		X	X		X	X											X	
METER INSTALLER	X	X	X				X	X	X		X	X		X													
ELECTROLYSIS TESTER	X	X	X	X	X			X	X		X	X	X	X	X												
LIGHTING DIRECTOR	X	X	X	X	X	X		X	X	X	X	X		X	X											X	X

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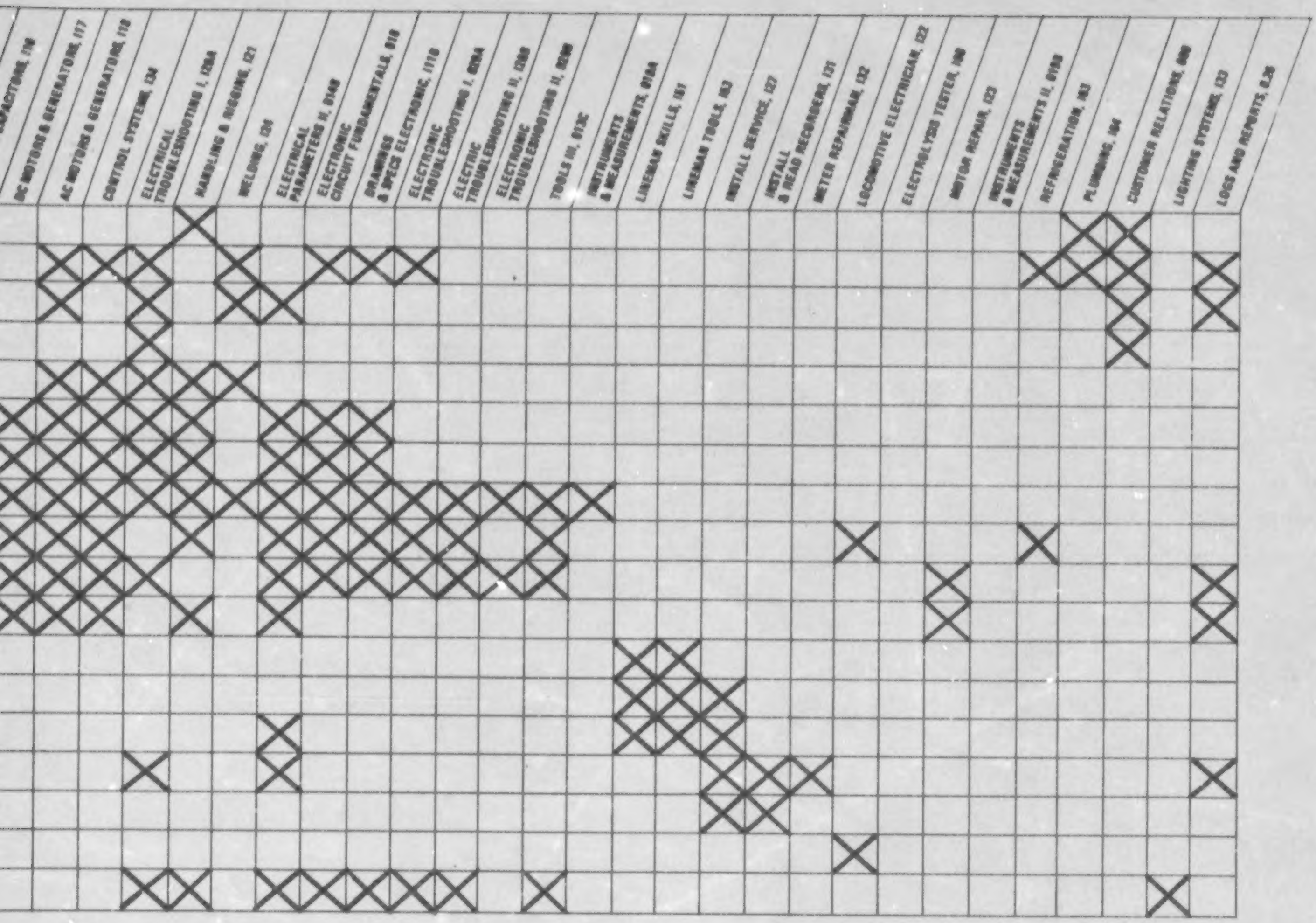
ENCE CHART
CATIONAL BLOCKS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TITLE: Safety

EDUCATIONAL BLOCK I.10

NOTES:
1. Safety is so broad that the instructor must limit the scope by using typical examples.
2. Safety should be covered as a separate block as well as periodically during the course and during specific tool usage.

REFERENCES:
1. American Red Cross, ed. Basic First Aid.
2. Illinois Power Company. Safety Manual.
3. Maine State Department of Education. Industrial Electricity Curriculum Manual.
4. National Safety Council. Posters, brochures.
5. Ohio Trade and Industrial Education Service. Electric Lineman.
6. Zbar, Paul B. Electricity-Electronics Fundamentals.

GENERAL OBJECTIVE: Work safely using proper safety equipment and following established safety practices, procedures and OSHA Standards.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Know first aid procedures.	First Aid (including artificial resustation)	8 hrs.
Identify first aid equipment and associate with proper usage.	Safety Equipment Blankets Stretchers Powder Fire Extinguisher First Aid Kit	3 hrs.
Know basic safety hazards and practices which exist in industry.	Basic Accident Prevention Safety Hazards Electrical Mechanical Chemical Heights Lifting Safety Practices Safety Equipment Glasses Hard Hats Safety Shoes Masks Tool Usage Safe Working Environment	4 hrs.
Show or exhibit safety awareness and responsibility.	Accidents Reports Results of Not Following Safety Rules	
Know about safety rules that apply or may apply to local industries.	Safety Rules and Regulations General Color Codes Symbols	

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME
Know OSHA requirements for local industry.	OSHA Regulations Inspections Reporting Requirements	2 hrs.
Know and be able to explain the safety rules, regulations and practices according to the applicable source.	Industrial Safety (Typical Example) Job Related Safety Rules Location of Safety Rules Failure to Comply with Safety Rules Safety Training Program	4 hrs.
Know the safety practices and equipment to be used when the voltage exceeds 500 volts.	Above 500 Volts Basic Safety Hazards and Practices Safety Rules Safety Equipment Rubber Blankets Rubber Sleeves Rubber Hoods Hot Sticks	2 hrs.
Consumer product safety.	Consumer Safety Guidelines Grounding Shorts Interlocks Fusing Polarization Radiation	2 hrs.

SUGGESTED PROCEDURE:

1. Use typical industries to illustrate those sections of the outline which would otherwise be too broad in scope.
2. Students should be required to take a first aid course.
3. Obtain and use industrial safety posters.
4. Schedule safety meetings once a month and then cover safety as it relates to the material being covered.
5. OSHA requirements are administered by: OSHA, Regional Office, 848 Federal Office Building, 219 S. Dearborn, Chicago, Illinois 60604.
6. Call on industrial safety people for guest presentations.
7. Many electricity or electronic lab books have sections on safety.
8. A Red Cross programmed first aid course (8 hrs.) is particularly useful.
9. Use examples and case histories showing the results of negligence.
10. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Basic Electrical Parameters I

EDUCATIONAL BLOCK 0.14.a

NOTES: This block might well be done concurrently with I.19.a (Instruments and Measurements I) so that the student measures these parameters as he is exposed to each in turn.

REFERENCES:
1. Devito, M. Introduction to Electricity-Electronics.
2. Grob, Bernard. Basic Electronics.
3. Malvino, Albert P. Electronic Principles.
4. Zbar, Paul B. Basic Electricity.

GENERAL OBJECTIVE: Define basic electrical parameters, their characteristics, units and inter-relationships; determining unknowns when given sufficient knowns.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define and characterize voltage.	Voltage as a Force Across Two Points Polarity (+) and (-) Magnitude Constant: DC Repetitive: AC, etc. Period Frequency E_{RMS} Units μ volts m volts K volts M volts	15 hrs.
Define and characterize current.	Current as the Rate of Directional Drift of Charge Through a Circuit Element Direction Magnitudes Constant: DC Repetitive: AC, etc. Period Frequency I_{RMS} m amps μ amps	6 hrs.
Define and characterize resistance.	Resistance as Opposition to Flow of Current OHMS K OHMS M OHMS	3 hrs.
Define and characterize power.	Power as Rate of Consumption of Energy m Watts Watts K Watts	3 hrs.

Basic Electrical Parameters I
0.14.a

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Determine voltage, given current and resistance. Determine current, given voltage and resistance. Determine resistance, given voltage and current. Determine power, given voltage and current. Determine current, given power and voltage. Determine voltage, given power and current. Determine frequency, given period.	Inter-relationships Ohms Law Watts Law Frequency vs. Time Methods of Solving for Unknowns Algebraic Manipulations Use of Nomographs	15 hrs.

SUGGESTED PROCEDURE:

1. If the mathematics background of student group precludes the use of algebra in calculation of unknown parameters, it is recommended that the use of nomographs such as those found in the Appendix be used, or teach the math as needed.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Component Identification

EDUCATIONAL BLOCK 0.16

NOTES: This block might be presented in conjunction with Block 0.17 (Functions of Electronic Components), permitting the component, symbol, and its function to each be taken in turn.

REFERENCES:
1. Allied Radio Catalog.
2. Klaus Radio Catalog.
3. Newark Electronics Catalog.
4. Other Electronic Component's Catalogs.

GENERAL OBJECTIVE: Identify common components in current use by their physical characteristics, schematic symbol, color coding, or printed specification, as well as to be able to interrelate these means of identification.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Provide the name, value, type, rating, and symbol of any of the listed components.	Wires and Connectors Wire Types Solid Stranded Co-Axial Cables Wire Sizes Gauge Sizes Connectors Terminals Jacks, Plugs, and Receptacles Sockets	2 hrs.
	Fuses and Breakers Types Plug Cartridge Delay Ratings	4 hrs.
	Switches Types Slide Toggle Rotary Pushbutton Microswitches Actions SPST SPDT DPST DPDT N.O. N.C. Momentary Ratings Relays Types Contacts	2 hrs.

Component Identification
0.16

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Resistors	2 hrs.
	Types	
	Carbon Composition	
	Wire Wound	
	Deposited Film	
	Color Code	
	Tolerances	
	Wattage	
	Potentiometers	
	Rheostats	
	Capacitors	2 hrs.
	Types	
	Paper	
	Ceramic	
	Mica	
	Electrolytic	
	Values	
	Ratings and DCWV	
	Tolerances	
	Color Code	
	Variable Types	
	Inductors	
	Types	
	Value	
	DC Resistance	
	DC Maximum Current	
	Transformers	2 hrs.
	Types	
	Power	
	Audio	
	Coupling	
	Tuned	
	Adjustable	
	Multiple Winding	
	Ratings	
	Vacuum Tubes	2 hrs.
	Types	
	Numbering System	
	Multiple	
	Special	
	Semiconductor Devices	4 hrs.
	Diodes	
	Special Diodes (Zener, Tunnel, etc.)	
	Transistors (BJT's, FET's, etc.)	
	Switches (SCR's, DIACS, TRIACS, etc.)	
	I.C.'s	
	Miscellaneous	8 hrs.
	Bulbs	
	Antennas	

Component Identification
0.16

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Microphone Speakers Solenoids Crystals Batteries Photocells Thermocouples Motors	

SUGGESTED PROCEDURE:

1. The instructor should have typical examples of these devices for student practice in identification. They can be loose, mounted with the appropriate symbol given, or mounted on display boards for student use.
2. Use catalogs to locate replacement parts such as those listed under references.
3. Schools should provide trade journals and magazines.
4. Clip coupons out of trade magazines to get free information.
5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Functions of Electrical Components

EDUCATIONAL BLOCK 0.17

NOTE: This block might well be sequenced in conjunction with Block 0.16 (Component Identification) so that the student learns to recognize components and their symbol as he learns their functions.

REFERENCES:
1. Churchman, L. Survey of Electronics.
2. Grob, Bernard. Basic Electronics.
3. Sands, Leo G. Electronics Handbook for the Technician.

GENERAL OBJECTIVE: Demonstrate knowledge of the functions and applications of common circuit components by locating faults in each under typical applications.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the primary functions and applications of common wires, cables and connectors.	Wire, Cables, and Connectors Power Distribution Signal Distribution Interconnections	2 hrs.
Describe the functions of typical fuses and breakers.	Fuses and Breakers Circuit Protection Purposes of Time Delay Low Value Resistance	2 hrs.
Describe the functions and applications of switches and relays.	Switches and Relays Circuit Interuption Distribution Control Signalling	2 hrs.
Describe the functions and applications of resistors.	Resistors Current Limiting Voltage Dropping Divide Voltage and Current Heaters	1 hr.
Describe the functions and applications of capacitors.	Capacitors Store Charge Block DC - Pass AC Pass High Frequencies Tuning Shift Phase	1 hr.
Describe the functions and applications of inductors.	Inductors Store Energy Block AC - Pass DC Pass Low Frequencies Tuning Shift Phase	1 hr.
Describe the functions and applications of transformers.	Transformers Step Voltage Up or Down Couple Isolate Match Impedances	2 hrs.

Functions of Electronic Components
0.17

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the primary functions and applications of diodes.	Diodes	2 hrs.
	Rectify	
	Switch	
	Waveform Modification	
	Clipping	
	Clamping	
	Limiting	
	Doubling, etc.	
	Applications of Special Diodes	1 hr.
	Voltage Regulation	
	Circuit Protection	
Describe the primary functions and applications of common types of vacuum tubes.	Vacuum Tubes	2 hrs.
	Amplify	
	Mix	
	Switch	
	Modulate and Demodulate	
	Modify Waveforms	
Describe the primary functions and applications of common types of semiconductors.	Transistors	2 hrs.
	Amplify	
	Switch	
	Mix	
	Modulate and Demodulate	
	Modify Waveforms	
	Integrate Circuits (IC's)(Typical Examples)	
	Electronic Switching Devices	
	(Diacs, Triacs, SCR's, Thyratrons)	
	Light Dimming	
	Speed Control	
	Current Control	
	Phase Control	
Describe the primary functions and applications of common types of sensors and transducers.	Transducers	2 hrs.
	Energy Conversion	
	Sensors	

SUGGESTED PROCEDURE:

1. The emphasis on this block should be directed to what each component does, that is, its function, not on how it accomplishes same or internal workings.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Circuit Configurations EDUCATIONAL BLOCK 0.15

NOTES: The treatment of these topics should be kept from getting excessively quantative. This is not meant to be a first course in rigorous network analysis.

REFERENCES:
1. Devito, M. Introduction to Electricity-Electronics.
2. Grob, Bernard. Basic Electronics.
3. Malvino, Albert P. Electronic Principles.
4. Siskind, Charles S. Electrical Circuits.

GENERAL OBJECTIVE: Demonstrate knowledge of series, parallel, series-parallel, and three phase circuits by determining unknown parameters.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Analyze series circuits to determine unknown parameters.	Series Circuits Common Current Equivalent R Voltage Drops Polarity Magnitudes Kirchoff's Voltage Law Power	3 hrs.
Analyze parallel circuits to determine unknown parameters.	Parallel Circuits Common Voltage Equivalent R Branch Currents Direction Magnitudes Kirchoff's Current Law Power	3 hrs.
Analyze series-parallel circuits to determine unknown parameters.	Series-Parallel Circuits Circuit Simplification Series Elements Parallel Elements Total Resistance Source Current Voltage Drops Branch Currents Power	3 hrs.
Analyze three-phase circuits to determine unknown parameters.	Three-Phase Circuits Y Connection Δ Connection Balanced Loads Load Voltages Load Currents Line Voltages Line Currents Unbalanced Loads Load Voltages Load Currents Line Voltages Line Currents	4 hrs.

SUGGESTED PROCEDURE:

1. In order to facilitate the students mastery of this material, much of the outline should be treated by demonstration and laboratory activity.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electrical Component Function and Identification   EDUCATIONAL BLOCK I.61

NOTES: This block might be presented with Blocks I.13.a.

REFERENCES: 1. Croft, Terrill, et. al. American Electricians Handbook.
2. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Identify common electric components by their physical characteristics, schematic symbol and printed specification.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Provide the name, value, size, type, symbols and function for the components listed in the outline.	Wires Wire Types Solid Stranded Co-Axial Cables Wire Sizes Gauge Flexible Steel Conduit Types Metal Clad Cable	4 hrs.
	Hand Boxes Outlet Switch Pull Octagon	1 hr.
	Connectors Soderless Crimp	2 hrs.
	Conduit (Thin Wall and Rigid) Lengths Diameter Capacity	4 hrs.
	Conduit Hardware Couplings Connectors Reducers Off-Sets Conduit Toggle Bolts Pipe Straps Concrete Inserts Concrete Hangers Bushing Locknuts	3 hrs.

SUGGESTED PROCEDURE:

1. The instructor should have examples for inspection and identification.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electrical Power Equipment Identification and Function

EDUCATIONAL BLOCK I.62

NOTES: This block may be presented in conjunction with Blocks I.51, I.27, I.32 or I.31.

REFERENCES: Ohio Trade and Industrial Education Service. Electric Lineman.

GENERAL OBJECTIVE: Identify common equipment used in the electric utility industry and its function and/or application.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Provide the name and symbol of any of the listed equipment on sight.	Equipment Listing: Poles Framing	8 hrs.
Identify the function and application of the listed equipment.	Cross Arms Insulators Anchors Wire and Cable Service Cable Wire Splices Meters and Bases House Brackets Ground Rods Ground Wire Meter Cabinets Instrument Transformers	8 hrs.

Electrical Power Equipment Identification
and Function
I.62

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.
2. Show pictures, slides, etc. of typical equipment.

TITLE: Drawings and Specifications (Electrical)
EDUCATIONAL BLOCK I.11.a

NOTES:
1. Because of the preponderance of specialized terminology, abbreviations and acronyms in the electrical field, they should be pointed out and emphasized throughout the educational sequence.
2. This block is designed to include architectural drawings.

REFERENCES:
1. Graham, Kennard C. National Electrical Code and Blueprint Reading.
2. Heine, Gilbert M. How to Read Electrical Blueprints.
3. Sundberg, Elmer W. Building Trades Blueprint Reading, Part I.
4. The Wiring Diagram--How to Read It--Interpret It--Use It. (Casette Tape).

GENERAL OBJECTIVE: Read and interpret conventional drawings, schematics, blueprints and specifications encountered in electrical occupations.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and describe conventional types of drawings, schematics, diagrams, graphs and charts encountered in electrical occupations.	Types of Drawings Block Diagrams Schematics Wiring Diagrams One-line Diagrams Three-line Diagrams Sketches System Map (Utilities) Pictorials Control Drawings Blueprints Architectural House Wiring Signal Wiring Motor and Generator Blueprints Graphs and Charts Bar and Pie Charts Volt-Ampere Graphs Characteristic Curves Nomographs	8 hrs.
Read and interpret standard electrical terminology, abbreviations and acronyms.	Glossary of Electrical Terms	1 hr.
Read and use standard electrical symbols and industrial variations.	Symbols Electrical Mechanical Architectural	4 hrs.

Drawings and Specifications (Electrical)
I.11.a

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Read and interpret conventional drawings, diagrams and charts used in electrical occupations.	Conventions of Electrical Drawings Lines Lettering Title Blocks Notes Date and Revisions (change letter) Bill of Materials Model and Serial Number Block Diagrams Schematics One-line Drawings Three-line Drawings System Maps Production Drawings Control Drawings Architectural Drawings	1 hr.
Identify and describe standard types of specifications used in the electrical industry.	Specifications Types of Specifications Operating Performance Contractual Architectural Cost Test Installation	1 hr.
Read and interpret conventional specifications for electrical equipment.	Specifications Content Input Current Voltage Power Ripple Frequency Output Voltage Current Power Frequency Stability Accuracy Environmental Temperature Vibration Humidity Shock Mounting Specifications	4 hrs.
Draw sketches of electrical units, using conventional practices.	Sketching	2 hrs.
Read, use and follow manufacturer's assembly and operating instruc-	Manufacturer's Data Operating Manual Shipping Manual Assembly Instructions	2 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Operate a polaroid camera.	Polaroid Camers Configuration Operation	1 hr.
Locate replacement parts using supply house catalogs.	Supplier Catalogs Typical Examples	1 hr.

SUGGESTED PROCEDURE:

1. The instructor should have a wide assortment of different types of drawings, diagrams, specification sheets and blueprints so that the students get experience in reading as many of the types as possible.

2. The student should also obtain a complete glossary, dictionary of electrical terminology and a diagram of typical electrical symbols used in electrical diagrams. See appendix.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Drawings and Specifications (Mechanical) EDUCATIONAL BLOCK I.11.c

NOTES: 1. The reference listed below has an excellent appendix containing symbols, tables, and a glossary, all very well done.

2. This block is very broad and the instruction must pick and choose appropriate topics to fit a particular occupation or occupations.

REFERENCES: Brown, Walter C. Blueprint Reading for Industry.

GENERAL OBJECTIVE: Read and interpret conventional mechanical drawings, blueprints, and specifications.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and describe conventional types of mechanical drawings, blueprints and specifications.	Types of Drawings Orthographic Pictorial Detail Assembly Sectional Layout Sketches Blueprints	2 hrs.
Read and use standard symbols, line systems, notations and terminology in mechanical drawings and blueprints.	Symbols Line Alphabet Notes Dimensions Tolerances Abbreviations	2 hrs.
	Mechanical Terms Glossary	2 hrs.
Read and interpret standard mechanical drawings including plumbing installation drawings.	Conventions and Mechanical Drawings Lettering Title Block Date and Change Letter Model and Serial Number List of Materials Threads Callouts Specifications for Machine Processes Gears, Splines Sheet Metal Position and Form	2 hrs.
Draw freehand sketches of mechanical systems following conventional techniques.	Sketching	2 hrs.
Use a simple polaroid camers for surveys.	Camera Usage	1 hr.

SUGGESTED PROCEDURE:

1. The instructor should have a wide assortment of different types of drawings and blueprints so that the students get as wide an exposure to the various types and systems used.

2. Further, the students should be provided with a good glossary of terms and diagrams of electrical, architectural, mechanical and welding symbols, as well as metric, decimal, and drill size equivalents.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electrical Codes　　EDUCATIONAL BLOCK I.12

NOTES: 1. This block should be taught both as a separate block and as an integral part of others as needed.

2. This block is organized around the national code and applicable variance as indicated by state and local codes should be included.

REFERENCES: 1. National Electrical Code.
2. Wa[illegible], John H. NFPA Handbook of the National Electrical Code.

GENERAL OBJECTIVE: Plan electrical circuits, purchase parts, and install electrical circuits and equipment in accordance with national, state, and local codes.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define terminology used in codes properly.	Terminology of Codes (Article 100)	10 hrs.
Locate codes applicable to job to be done.	Code Organization and Structure (Article 110)	10 hrs.
Determine electrical codes and select proper breaker, wire, and service equipment and parts according to National Code Articles 200-280.	Wiring Design and Protection Use of Conductors Branch Circuits Feeders Services Overcurrent Protection Grounding Lighting Protection	40 hrs.
Select proper wiring methods for job according to National Code Articles 300-390.	Wiring Materials and Methods Temporary Wiring Conductors for General Wiring Continuous Rigid Cable Supports Open Wiring Sheathed Cables Entrance Cables Underground Cables Extensions Conduit and Tubing Raceways Wire Ways Flat Cable Bus and Cable Ways Boxes and Fittings Switches	30 hrs.
Wire equipment for general use according to National Electrical Code Articles 400-480.	Equipment for General Use Flexible Cords and Cables Flexible Wires Lighting Equipment	20 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Appliances Electrical Heating De-Icing and Snow Melting Motors, Motor Circuits and Controllers Air Conditioning and Refrigeration Generators Transformers Capacitors Resistors and Reactors Storage Batteries	
Wire special occupancies and special equipment under special conditions according to National Electrical Code Articles 500-555, 600-680, 700-750, and 800-820.	Special Occupancies Hazardous Locations Commercial Garages Residential Garages Hangers Service Stations Health Care Facilities Theaters, etc. Mobile and Recreational Vehicle Facilities Marinas	15 hrs.
	Special Equipment Signs and Lighting Cranes and Hoists Elevators and Escalators Welders Recording Equipment Data Processing Systems Organs X-Ray Equipment Industrial Tools	10 hrs.
	Special Conditions Emergency Systems Over 600 Volts Low Voltage (Under 50V) Remote and Signal Circuits Outside Circuits Stand-by Systems	10 hrs.
	Communications Systems Communication Circuits Radio and TV Equipment CATV	10 hrs.

SUGGESTED PROCEDURE:

1. Have students look up specifications for jobs in code book.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Cleaners and Lubricants

EDUCATIONAL BLOCK I.25

NOTES: This is a partial listing of cleaners and lubricants used on electricity and electronics equipment.

REFERENCES: 1. G. C. Electronics Catalog, Rockford, Illinois.

GENERAL OBJECTIVE: Select and properly use different types of electrical and electronic cleaners, lubricants, and insulating materials.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Select and properly use cleaners.	Contact Cleaners (aerosol) Ethyel Alcohol Cleaning P.C. Boards	2 hrs.
Select and properly use lubricants.	Oils Silicone Lubricants	2 hrs.
Select and properly use insulating materials.	Tapes Varnish Motor Wire Insulation Transformer Wire Insulation Corona Dope High Voltage Insulation High Voltage Putty	2 hrs.
Select and properly use sealing, bonding and potting materials.	Epoxy Silicone Potting Compound	2 hrs.
Select and properly use circuit coolants.	Circuit Freeze (aerosol)	1/2 hr.

SUGGESTED PROCEDURE:

1. The instructor should have examples for inspection and identification.

TITLE: Hand Tools and Hardware I

EDUCATIONAL BLOCK 0.13.a

NOTES:
1. For the electrician, some of these tools may need to be skipped such as wire wrapper, riveters, and alignment tools.
2. This block should include sharpening and dressing of tools when applicable.
3. Hand tools is intended to include electric and pneumatic tools as needed.

REFERENCES:
1. Duarte, Salvador R., and Duarte, R. L. Electronics Assembly and Fabrication.
2. Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Demonstrate proficiency with common hand tools by selecting, properly using, and caring for the tools needed in performing typical jobs.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME
Properly use common hand tools in the assembly-disassembly of electronic, electrical and electromechanical equipment.	Screwdrivers Types Standard Blade Phillips Cross-Head S Screw Holding, etc. Nut Drivers Pliers Longnose Curved Nose Slip-Joint Gas Side Cutters Fuse and Tube Pullers Vise Grip Wrenches Box End Open End Sockets Adjustable Allen Riveters Chisels Torque Wrench Levels	8 hrs.
Properly use common hand tools in the construction and modification of electronic, electrical and electromechanical hardware systems.	Saws Hacksaw Sabre Saw Hole Saw Drills Electric Hand Rotary Impact	8 hrs.

Hand Tools and Hardware I
0.13.a

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Punches	
	Socket	
	Knockout	
	Center	
	Hammers	
	Files	
	Rules and Layout Tools	
	Nibblers and Snips	
	Taps and Dies	
	Vises	
	Clamps	
	Wire Stripper	
	Knives	
	Crimpers	
	Wire Wrappers	
Identify common screw sizes and types.	Screws	8 hrs.
	Types	
	Sheetmetal	
	Machine	
	Threads	
	Sizes	

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.
2. Show pictures, slides, etc. of different tools.

TITLE: Soldering Skills

EDUCATIONAL BLOCK 0.50

NOTES: This block can be placed just about anywhere in an educational sequence so long as it proceeds any construction or repair activities.

REFERENCES:
1. Herrick, Clyde. Assembly Techniques.
2. Illinois Bell Film Library. Soldering.
3. Solder -- It's Fundamentals and Usage

GENERAL OBJECTIVE: Properly install and remove electrical/electronic components employing suitable soldering equipment and techniques.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the purposes and characteristics of the proper solder joint.	Mechanical Support of Components	2 hrs.
	Minimal Resistance	
	Appearance Smooth Shiny Proper Amount of Solder	
	Soldering Standards Industry NASA Military	2 hrs.
Use wire strippers, knives, and side cutters to strip insulation from typical wires and cables without nicking the conductor.	Plastic Covered Wire	6 hrs.
	Cloth Covered Wires	
	Solid Conductor Wires	
	Stranded Conductors	
	Co-axial Cables	
Properly tin conductors and terminals to assure perfect solder joint.	Application of Heat	1 hr.
	Application of Solders	
Connect and wrap leads and terminals to provide sufficient mechanical support to components to be mounted.	Wrapping	2 hrs.
	Crimping	
	Wire Wrap	
Select the right soldering iron for typical soldering jobs in electrical-electronic systems.	Sufficient Heat and Dangers of Overheating Wattage Heavy Soldering Soldering to Terminals Soldering to PC Boards	2 hrs.
	Care and Dressing of Soldering Tips	1 hr.
Select the proper solder and fluxes for given soldering task.	Ratios of Solder	1 hr.
	Types of Flux	
	Functions of Flux	
	Cleaners	

Soldering Skills
0.50

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Properly apply heat, flux, and solder to form perfect solder joint.	Application of Heat to Lead Solder Flow Holding Components Heat Sinks Cooling	4 hrs.
Unsolder components from hand-wired as well as printed circuits without damage to circuit or circuit components.	Application of Heat Dangers of Over-Heating Avoidance of Splatter Techniques of Solder Removal Braid Solder Suckers Use of Soda Straw	2 hrs.
Identify special techniques of soldering encountered in electrical/electronic systems.	Grounded Tip Irons Variable Heat Irons Soldering Large Gauge Wire Solder Forms Soldering Compounds	2 hrs.
	Solder Wave Baths Dip Soldering	5 hrs.

SUGGESTED PROCEDURE:

1. For this block, it is recommended that the instructor obtain scrap components, PC boards, terminal strips, wires, etc., available at minimal cost as scrap from sources such as local industry, surplus outlets, etc. These can then be mounted so as to provide a wide range of typical conditions under which soldering is to be done.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements I

EDUCATIONAL BLOCK I.19.a

NOTES:

1. This unit may best be handled in conjunction with Block 0.14.a (Basic Electrical Parameters) intermeshed so that the student learns to measure parameters listed immediately after each is covered in turn in parameter the block or these topics may be covered as the need arises.

2. Although it is not spelled out in the outline, VOM is meant to include multimeters and further, that the meters can be either the usual analog readout types as well as digital readout types.

REFERENCES:

1. Allied Radio Corp. Best Ways to Use Your VOM and VTVM.
2. Allied Radio Corp. Understanding and Using Your Oscilloscope.

GENERAL OBJECTIVE: The student will properly employ VOM's and VTVM's, clamp-on meters, and oscilloscopes to accurately measure voltages, currents, resistance, frequency, and common waveforms; all with the maximum precision and accuracy capabilities of each instrument.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of the VOM, VTVM, clamp-on meters, and oscilloscope, and to select the best instrument for a given measurement.	Instrument Characteristics Capabilities of Each Accuracy Reading Scales Sensitivity Loading Effects Care of Instruments Calibration	8 hrs.
Measure with the full accuracy and precision of the instruments listed the magnitude, polarity, waveform, and frequency of any voltage within range of instruments listed.	Voltage Measurements VOM - DC & AC VTVM - DC & AC Clamp-on Meter - AC Oscilloscope - Any Waveform Voltage Testers - AC	15 hrs.
Measure with the full accuracy and precision of the instruments listed the magnitude, direction, frequency, and waveform of any current within the range of instruments listed.	Current Measurements VOM - DC VTVM - DC Clamp-on Meters - AC Meters and Scope with Precision 1Ω Shunt	20 hrs.
Accurately measure resistance utilizing the full precision and accuracy of available VOM and VTVM.	Resistance Measurements Continuity With VOM With VTVM	4 hrs.
Identify common waveforms with the oscilloscope and determine their frequency from measured period.	Waveform Identification Use of Oscilloscope	5 hrs.
	Frequency Measurement with Oscilloscope Period (T) $F = \frac{1}{T}$	5 hrs.

SUGGESTED PROCEDURE:

1. This basic measurements unit is facilitated nicely through the use of a lab distribution system. That is, a pair of terminals at each lab station that are all interconnected through a twisted pair. This permits each student to be measuring the same quantity at the same time.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements II
EDUCATIONAL BLOCK I.19.b

NOTES: These instruments include those that are common to the industrial electrician.

REFERENCES:
1. Available Equipment Manuals and Specifications.
2. Instrument Manufacturer's Catalogs.

GENERAL OBJECTIVE: Select, use properly, and care for special indicators and instruments typically used in electrical occupations.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of meggers, continuity checkers, test lamps, voltage indicators, watt meters, watt-hour meters, light meters, sound level meters, temperature indicators and recording meters.	Instrument Characteristics Capabilities of Each Accuracy Reading Scales Sensitivity Care of Instruments	8 hrs.
Measure voltage levels with the instruments listed.	Voltage Measurement Test Lamp Voltage Indicators Recording Voltmeters	1 hr.
Measure with the full accuracy and precision of common meggers the magnitude of resistance.	Resistance Measurement Megger	2 hrs.
Determine the existance or non-existance of continuity with the instruments listed.	Continuity Testing Continuity Checkers Ohm-Meters Meggers	2 hrs.
Measure with full accuracy and precision of instruments listed magnitudes of power and energy.	Power and Energy Watt-Meters VOM Adapters Watt-Hour Meters	4 hrs.
Measure with full accuracy and precision of instruments listed existing ambient conditions of work areas.	Light Meters Sound Level Meters Temperature Meters Recording Meters	4 hrs.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Use equipment manuals. Typical manufacturers are:
    - Simpson Electric Company, Chicago, Illinois.
    - Amprobe Instrument, Lynbrook, New York.
    - (Meggar) James J. Biddle Company, Plymouth Meeting, Pennsylvania.

3. Use large scale mock-ups of meter faces and selector switches.

TITLE: Wiring I

EDUCATIONAL BLOCK I.13.a

NOTES: Wiring I covers rough wiring for non-metallic sheathed cable (Romex), armored cable and flexible conduit. Interior Wiring II will cover rigid and thin wall conduit.

REFERENCES:

1. Adams, James E. Electrical Principles and Practices.
2. Alerich, Walter N. Electrical Construction Wiring.
3. Croft, Terrill, et. al. American Electricians Handbook.
4. Graham, Kennard C. Interior Wiring - Residential.
5. Marcus, Abraham. Electricity for Technicians.
6. Mileaf, Harry. Electricity One-Seven.
7. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
8. Richter, Herbert P. Wiring Simplified.
9. Sears Roebuck Company. Simplified Electrical Handbook.
10. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Select and install common wiring systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install wiring boxes in or on floors, walls and surfaces.	Wiring Boxes Outlet Utility Sectional Switch Floor Pull Boxes	8 hrs.
	Box Accessories Covers Extension Rings	8 hrs.
	Surfaces (Interior and Exterior) Masonry 2 x 4 Studs Plaster Sheet Roll Wood Siding Aluminum Siding Steel Siding Vinyl Siding	8 hrs.
	Installation Hardware Staples Pipe Straps Toggle Bolts Beam Straps Wall Board Hangers Ground Rods Ground Clamps Hickeys	8 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install a mast type or underground service entrance in or on surfaces as listed in the outline including meter box, ground rod and distribution panel.	Entrance Service Conduit Grounding Meter Box Entrance Panel Overhead Specification Clearance, etc.	6 hrs.
Install non-metallic sheathed cable from entrance panel to outlet box.	Non-Metallic Sheathed Cable Types (NM and NMC) Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	20 hrs.
Install greenfield (Flexible Conduit) from outlet box to electrical load.	Flexible Steel Conduit Types AC and MC Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	2 hrs.
Install low voltage wiring and components.	Low Voltage Systems Furnace Antenna Systems Intercom Door Bell	5 hrs.
Install armored cable from outlet box to electrical load.	Metal Clad Cable Types AC and MC Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	2 hrs.

SUGGESTED PROCEDURE:

1. See Reference #10 for detailed steps.

2. Construct a 8 foot 2 x 4 wall and install service entrance, circuit breaker panel and outlets.

3. Use electrical equipment manufacturer's catalogs.

4. In conjunction with building construction, the class could wire a house. This would require additional time.

5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Tools II (Electrical) EDUCATIONAL BLOCK 0.13.b

NOTES: 1. There are special tools required of the electrician which are not covered in Block 0.13.a.

2. Actual tool usage can be covered with the blocks as the skill is being presented.

3. Time does not include tool usage

REFERENCES: The Bending System, Republic Steel Corporation.

GENERAL OBJECTIVE: Select and use the correct electrical tools.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Select and use hand and power tools for installing conduit.	Rigid Conduit Power and Hand Benders Hand and Power Reamers Vise Hand and Power Threaders Thin Wall Hand Benders Reamers Crimpers Saws Hacksaw (Hand) Hacksaw (Power) Hole Saw Impact Wrench Pipe Cutter	12 hrs.

SUGGESTED PROCEDURE:

1. Use illustrations to show the student the physical characteristics of the tools.
2. Use the tools when demonstrating the skills of Blocks I.13.b.
3. Use material on conduit tools from Benfield Bender Co. and Rigid Tool Co. or other typical conduit tool companies.
4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Wiring II

EDUCATIONAL BLOCK I.13.b

NOTES: 1. Wiring II covers thin wall and rigid conduit. Other wiring systems (open wiring, metal raceways, under floor raceways, bus duct, etc.) are not covered.

2. Conduit usage in this block is limited to two inch.

REFERENCES:
1. Bending the Bendfield Way.
2. Croft, Terrill, et. al. American Electricians Handbook.
3. Marcus, Abraham. Electricity for Technicians.
4. Mileaf, Harry. Electricity One-Seven.
5. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
6. Richter, Herbert P. Wiring Simplified.
7. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Install common wiring systems including materials and devices.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Use a knockout punch for cutting holes in wiring boxes.	Wiring Boxes Outlet Utility Sectional Etc.	1 hr.
Mount electrical equipment cabinets, panels and boxes on various type surfaces as listed in the outline.	Electrical Equipment Cabinets Meter Cabinets Disconnect Cabinets Disconnect Switches Distribution Panel Starter Switches Branch Circuit Panel	12 hrs.
Mount and wire electrical controls.	Electrical Controls Float Switches Thermostats Pressure Switches	3 hrs.
Install surface metal raceway.	Surface Metal Raceway Types One Piece Two Piece Pancake Sizes Capacity Codes Fittings Wall Clips Elbows Switches Receptacles	2 hrs.
Cut rigid and thin wall conduit using hand and power cutters.	Conduit (Thin Wall and Rigid) Standard Lengths Standard Diameters Capacity	1 hr.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Ream rigid conduit.	See Block 0.13.b	5 hrs.
Thread rigid conduit using hand or power threaders.	See Block 0.13.b	2 hrs.
Bend kicks, saddle and 90° bends in rigid conduit using power threaders.	See Block 0.13.b	6 hrs.
Bend kicks, saddle and 90° bends in thin wall conduit using hand threaders.	See Block 0.13.b	6 hrs.
Install conduit wiring boxes and panels in or on floors, walls and various type surfaces as listed in the outline.	Conduit Hardware Couplings Connectors Reducers Off Sets Conduit Toggle Bolts Pipe Straps Concrete Inserts Conduit Hangers Bushings Locknuts Explosion Proof	15 hrs.
Install wire in conduit.	Wire Solid Stranded Wire Material Sizes Ampacity Insulation	15 hrs.
Know and identify waterproof wiring systems.	Fixtures Hardware	

SUGGESTED PROCEDURE:

1. Reference Number 7 is a most complete reference available and is of sufficient detail to be very helpful.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Rewire and Modify EDUCATIONAL BLOCK I.45

NOTES: 1. This block would include single and three phase.

2. This block should be sequenced closely with Blocks I.13.a and I.13.b.

REFERENCES: Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.

GENERAL OBJECTIVE: Install in existing buildings in accordance with applicable code, new electric circuits and equipment.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify location and path of new circuit.	Conduit Ducts Crawl Space Attic Hidden or Visible	2 hrs.
Identify method of installation.	Surface Metal Raceway	1 hr.
Identify need for increasing size of the service.	Estimate Load Existing New	2 hrs.
Identify new circuit breaker or fuse requirements. Identify new circuit capacity and wire size.	Electrical Load Size Distance	2 hrs.
Identify new circuit connection point.	Connection Points Entrance Panel Junction Boxes	4 hrs.
Identify and know the function of special tools and devices used for rewiring.	Tool and Devices Hanger Strips Surface Wire and Outlets Outlet Boxes with Compression Straps Extension Drills	6 hrs.
Identify and know the function of special rewiring techniques.	Wiring Behind Baseboards Wiring in Lath and Plaster Wiring in Wallboard Wiring in Two Story Structures Surface Wiring Installing Additional Circuits Installing Expanded Service Panel	6 hrs.

SUGGESTED PROCEDURE:

1. Using existing electrical plans have the student layout and size new circuits.

2. Use electrical devices and manufacturer's catalogs. Typical manufacturers are:
   - Hubbell Wiring Devices, Bridgeport, Connecticut
   - All-Steel Equipment, Aurora, Illinois
   - Rawlplug Co., New Rochelle, New York
   - General Electric, Providence, Rhode Island

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Switches, Fuses and Circuit Breakers

EDUCATIONAL BLOCK I.14

NOTES: It is assumed the units mentioned herein have been mounted. This block could be considered as finished wiring.

REFERENCES:
1. Croft, Terrill, et. al. American Electricians Handbook.
2. Form SFB. Bussman Mfg. Division.
3. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
4. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Select, install and connect switches, fuse and circuit breaker panels.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install circuit breakers or fuses in a panel board (Main or branch). Plan and layout connections in a panel board.	Fuses (See Reference #2) Characteristics Current Rating Voltage Rating Fast Acting Time Delay Dimensions	2 hrs.
Size the circuit breaker at fuse to the circuit load (110V and 220V).	Types Cartridge Ferrule Knife Blade Plug Fuses Fuse Reducers Fuse Holders	2 hrs.
Connect 110V and 220V cables with ground to the proper circuit breakers and neutral bus. Connect the meter box to the panel board.	Circuit Breakers Characteristics Current Rating Voltage Rating Ground Fault Protection Types Magnetic Thermal Magnetic Current Limiting Fused Circuit Breakers Time Delay	3 hrs.
	Panel Boards Surface Mount Flush Mount	2 hrs.
Install and connect common switches in outlet boxes.	Switches (See Reference #2, Page 4-2) Classification According to: Number of Poles Number of Closer Positions Type of Contact Number of Breaks Method of Insulation Method of Operation	4 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Speed of Operation	
	Enclosure	
	Type of Service	
	Common Switches	
	Knife	
	Safety	
	Toggle	
	Push Button	
	Electromagnetic	
	Tumbler	
	Fusible	
	Door Switches	
Install outlets.	Outlets	2 hrs.
	110V	
	220V	
	Single Phase	
	Three Phase	

SUGGESTED PROCEDURE:

1. Use and make transparencies from manufacturer's catalogs.
2. Obtain examples of fuses and circuit breaker panels for display.
3. Use existing panels at the school for illustration.
4. Typical manufacturers are: General Electric Company, Bridgeport, Connecticut.

   Bussman Manufacturing Company, St. Louis, Missouri.

   Square D Company, Park Ridge, Illinois.
5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Connect Basic Circuits

EDUCATIONAL BLOCK I.15

NOTES: This block should be taught with Blocks I.13.a and I.13.b.

REFERENCES:
1. Croft, Terrill, et. al. American Electricians Handbook.
2. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
3. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Connect basic electrical circuits.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Connect a lighting circuit, one or more lights, using a SPST switch or lamp dimmer.	Lighting Circuits Incandescant Flourescent Three-Way Four-Way Lighting Circuit Voltages	10 hrs.
Connect a switched outlet circuit using a SPST switch.	Switches (See Block I.14) Dimmers	
Connect a lighting circuit controlled from two locations using a three-way switch connection.		
Connect a lighting circuit controlled from three locations using a four-way switch connection.		
Connect 110V and 220V electrical equipment loads including electrical heating.	Non-Lighting Loads (110V and 220V) Range Water Heater Pump Motor Dryer Garbage Disposal Electrical Heating Outlets 110V and 220V Single Phase Receptacles	8 hrs.
Make electrical connections using common cable joints, connections and terminations as listed in the outline. (See 0.13.a for tools)	Electrical Cable Joints, Connections and Terminators Stripping and Cleaning Wire Ends Copper Sleeves Split Compression Terminal Lugs Solder Compression	12 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Pig Tail Connectors Screw-on Crimp Types with Insulating Caps Set Screw with Screw on Caps Bolted Pressure Connectors Setscrew Straight Coupling Types Split-bolt Types Clamp-on Types Cable Connector Tools (See Block 0.13.a) Soder (Block 0.50)	

SUGGESTED PROCEDURE:

1. See Reference Number 3 for detailed steps.
2. Use electrical equipment manufacturer's catalogs.
3. Have the students study a floor plan and from a manufacturer's catalog, list the material needed.
4. Typical manufacturers are: Leviton, Little Neck, New York.
   Amp Specialties, Valley Forge, Pennsylvania.
   Burndy Corporation, Norwalk, Connecticut.
   Cutler Hammer, Milwaukee, Wisconsin.
   General Electric, Providence, Rhode Island.
   Ideal Industries, Sycamore, Illinois.
5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Transformers and Capacitors

EDUCATIONAL BLOCK I.16

NOTES: 1. This block is intended to cover industrial devices.

2. Can be covered along with Block 0.14.b.

REFERENCE: 1. Croft, Terrill, et. al. American Electricians Handbook.

GENERAL OBJECTIVE: Install and maintain capacitors and transformers.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Know the function and types of transformers.	Transformers Schematic Symbol Primary Secondary Types Step-Up Step-Down Auto Voltage Current Control Matching Isolation Three Phase Polarity Markings Cooling Ratings Voltage Current Power Core Material	4 hrs.
Know how to connect single and three phase transformers.	Terminals (Connectors) Polarities Phasing	2 hrs.
Know the function and types of industrial capacitors.	Capacitors Function Schematic Symbol Polarities Types Units Ratings Voltage Power Hanger	3 hrs.
Know how to install and connect capacitors.	Terminals Polarities	1 hr.

SUGGESTED PROCEDURE:

1. Use pictures or other descriptive material available from Allis Chalmers, General Electric and other typical manufacturers.

2. Small transformers should be available for actual use in class.

3. Students could wind a simple transformer given core, wire, and specifications.

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: DC Motors and Generators

EDUCATIONAL BLOCK I.17

NOTES: This block can be taught in conjunction or sequence with Block I.18.

REFERENCES:
1. Adams, James E. Electrical Principles and Practices.
2. Allis Chalmers. A Guide to Care of Electrical Motors.
3. Loper, Oria. Direct Current Fundamentals.
4. Maine State Department of Education. Industrial Electricity Curriculum Manual.
5. Rosenberg, Robert. Electric Motor Repair.

GENERAL OBJECTIVE: Install, connect and maintain DC motors and generators.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
State the principles and sketch the circuits for different types of DC motors and generators.	DC Motors Types Series Shunt Compound Permanent Magnet Windings Field Armature Control	10 hrs.
Connect DC motors and generators in accordance with blueprints and nameplate.	Name Plate Data Type Voltage (input) Current (input) Wiring Diagram Blueprints (See Block I.11.a)	2 hrs.
Reverse a motor by changing the leads.	Motor Rotation	1 hr.
Check and replace brushes.	Brushes Function Grades Sizes Shades Material	2 hrs.
Install DC motors and generators.	Location Mounting Drive Belt Chain Gear Leveling	4 hrs.
Maintain DC motors and generators.	Belt Adjustments Cleanliness Heating Cooling	2 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Lubricate motors.	Lubricants Oil Grease	1 hr.
Determine condition of armature windings of rotating machinery.	Open Windings Shorted Windings Winding Short to Armature Frame Growler VOM	4 hrs.

SUGGESTED PROCEDURE:

1. Pictures of typical motors and installations would be useful.
2. Use illustrations from References #2 and #5 and electrical motor manufacturer's catalogs.
3. Typical motor manufacturers are: General Electric Company, Fort Wayne, Indiana.

   Dayton Electric Company, Chicago, Illinois.

   Westinghouse, Lima, Ohio.
4. Assemble and disassemble a DC motor.
5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: AC Motors and Alternators EDUCATIONAL BLOCK I.18

NOTES: This block is intended to cover single and three phase motors and alternators.

REFERENCES:
1. Adams, James E. Electrical Principles and Practices.
2. Allis Chalmers. A Guide to Care of Electrical Motors.
3. McIntyre, R. L. Electric Motor Control Fundamentals.
4. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
5. Rosenberg, Robert. Electrical Motor Repair.
6. State of Maine Department of Education. Industrial Electricity Curriculum Manual.

GENERAL OBJECTIVE: Install, remove, connect and perform minor repairs on AC motors and alternators.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
State the principles and sketch the circuits for the different types of AC motors and alternators.	Types of AC Machines Split Phase Motors Capacitor Polyphase Synchronous Shaded Pole Series Alternators	16 hrs.
Connect or wire single and three phase motors in accordance with blueprints or name plates.	Name Plate Data Voltage Current Wiring Diagram KVA	2 hrs.
Reverse a motor by changing the leads.	Motor Rotation Principles	1 hr.
Test a motor for shorts and grounds.	Motor Repair Tools Growler VOM	2 hrs.
Check and replace motor capacitors.	Motor Capacitors Uses Running Starting Types Oil Electrolytic Dry Voltage Rating Capacitance Rating	2 hrs.
Check and change centrifical switches.	Centrifical Switches Type Ratings	2 hrs.
Check, clean and replace brushes.	Commutator and Brushes	2 hrs.
Check bearings.	Lubrication Alignment	2 hrs.

SUGGESTED PROCEDURES:

1. Pictures of typical motors and installations would be useful.
2. Use illustrations from references #2, #3, and #4 and equipment catalogs from General Electric, Westinghouse, Emerson, Dayton and Allis Chalmers, or other typical manufacturers.
3. Assemble and disassemble an AC motor.
4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Install and Connect Industrial Controls EDUCATIONAL BLOCK I.34

NOTES: This block is limited to motor and generator control equipment. This block includes electrical, electronic, electromagnetic and magnetic control equipment. This unit is intended to cover motor controls only.

REFERENCES:
1. Alerich, Walter N. Electric Motor Control.
2. Croft, Terrill, et. al. American Electricians Handbook.
3. Fuchs, David and Garstang, S. Electric Motor Control and Circuits.
4. Industrial Control Laboratory Manual.
5. McIntyre, R. L. Electric Motor Control Fundamentals.
6. Maine State Department of Education. Industrial Electricity Curriculum Manual.
7. Motor Control Fundamentals.
8. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
9. Standard Control Circuits.
10. TPC Training Systems.
11. USOE. Construction Occupations Curriculum Project.
12. Wickey and Newman. AC Motor Control.

GENERAL OBJECTIVE: Install and connect industrial controls.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe and sketch a simple or three phase branch motor circuit showing each element as listed in the outline.	Motor Branch Circuits Elements Conductors Over Current Protection Disconnecting Method Motor Over Current Protection Controller Remote Control Motor Current Full Load Over Load Starting	8 hrs.
Install motor control station in accordance with NEMA Standards. A. Install and correct start and stop stations, including remote and reduced voltage. B. Choose correct starter sizes. C. Install correct heater sizes for overload relays. D. Install and connect controllers for forward and reverse operations. E. Install and connect manual-automatic selector switches. F. Install and connect forward, reverse and jog buttons.	Motor Controllers Circuit Breaker Manual Magnetic Terminal or Connection Identification Sizes Over Load Protection Enclosures Start-Stop Reverse Speed Control Motor Circuits Motor Disconnects	16 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
G. Install and connect two speed starters.		
H. Install multiple start-stop Stations.		
I. Install start-stop stations controlling multiple starters.		
J. Install multiple starters controlled by multiple start-stop stations.		
K. Install motor starters for sequence control		
Install and connect time delay relays.	Time Delay Relays	4 hrs.
Install limit switches.	Limit Switches	2 hrs.
Install pilot lights	Pilot Lights	2 hrs.
Install control logic circuits.	Basic Logic Relay Solid State	8 hrs.
	Industrial Controls Nor-Pak Statotrol	4 hrs.

SUGGESTED PROCEDURE:

1. This unit may be difficult to implement because of the sizes, cost and complexities involved.

2. Pictures of typical motors and installations would be helpful.

3. Use illustrations and make transparencies from equipment manufacturer's catalogs such as: Square D., Cutler Hammer, Allen Bradley, General Electric and Clark Control Division, A.E. Smith Corporation. For Example: Controlog, A Quick Reference Catalog of Electrical Controls, The Clark Control Company, Cleveland, Ohio 44110.

4. Field trips to local automated plants featuring controls would be helpful and create interest in application.

5. This unit may best be taught using a "hands-on" approach. The purchase of controls through local suppliers or in package format will give students an opportunity to look up and test various circuits. Although motor controls tend to be more expensive than residential materials, careful selection can lead to a sound program at minimal cost.

6. See Appendix for Motor Control Demonstration Board. Courtesy of University of Pennsylvania.

7. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electric Troubleshooting I

EDUCATIONAL BLOCK I.20.a

NOTES: This unit should be preceded by Block I.19.a (Instruments and Measurements I) as the use of basic instruments is assumed. Further, this unit can be sequenced along with Block 0.16.

REFERENCES: Grob, Bernard. Basic Electronics.

GENERAL OBJECTIVE: Locate and identify common faults of electric components typically found in electric circuits.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Select the proper test instrument and locate typical faults in common wires, cables and connectors.	Wires, Cables, and Connectors Opens Shorts Insulation Breakdown Resistance or Opens in Connectors	2 hrs.
Select the proper test instrument and locate typical faults in common fuses in breakers.	Fuses and Breakers	1 hr.
Select the proper test instrument and locate typical faults in switches and relays.	Switches and Relays Burned Contacts Faulty Linkages Open or Short Coils	1 hr.
Select the proper test instrument and locate typical faults in resistors.	Resistors Opens Shorts Change in Resistance Intermittants	1 hr.
Select the proper test instrument and locate typical faults in capacitors.	Capacitors Shorts Opens Leakage	1 hr.
Select the proper test instrument and locate typical faults in inductors and transformers.	Transformers and Inductors Shorts Windings Windings to Core Opens Ringing	2 hrs.
Select the proper test instrument and locate typical faults in motors and generators.	Motors and Generators Worn Brushes Open Leads Open Windings Short Windings	2 hrs.

SUGGESTED PROCEDURE:

1. The instructor should have on hand a supply of faulty components that reflect listed faults so that the student can evaluate and troubleshoot each.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Handling and Rigging

EDUCATIONAL BLOCK I.21

NOTES: 1. This block covers a wide range of handling and moving jobs and equipment.

2. This block is closely related to O.13.a.

REFERENCES: USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Install, remove and transport bulky and heavy electrical equipment and appliances.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Properly use lifting devices.	Hoists	2 hrs.
	Chain	
	Ratchet	
	Pulley	
	Pole	
	Bars	
	Pinch	
	Crow	
Properly use ropes and chains.	Slings	2 hrs.
	Chains	
	Ropes	
	Couplings	
	Knots	
	Nets	
Properly use moving equipment.	Dollies	2 hrs.
	Hand Carts	
	Roller Bars	
	Slides (Incline)	
	Skids	

SUGGESTED PROCEDURE:

1. Identify these tools and equipment using pictures, slides, etc. Actual usage does not seem practical except for limited items.

2. Use manufacturer's catalogs. Typical manufacturers are:
    Coffing Hoist, Charlotte, North Carolina
    Pole-Heister, General Machine Products Co., Trevose, Pennsylvania
    Ratciff Hoist Co., Belmont, California

TITLE: Welding Skills

EDUCATIONAL BLOCK I.24

NOTES: 1. The time allotted does not include actual student participation.

2. The most important topics here are arc welding and torch cutting. If time is insufficient, do these two only.

REFERENCES: Ludwig, Oswald A., and McCarthy, Willard J. Metalwork Technology and Practice.

GENERAL OBJECTIVE: Properly perform both arc and oxy-acetylene welding as needed in electrical occupations according to welding society codes.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the theory of the oxy-acetylene welding process; setup pressurize, test, light, extinguish and drain system.	Set Up Equipment Tanks Generators Safety Regulate Pressures	1 hr.
Cut mild steel with oxy-acetylene equipment.	Cut Flat Stock Angle Iron Side Wall Boiler Tubes	1 hr.
Lay out work to be welded.	Layout Flat Work Patterns Templates T Joints Y Joints Angle Joint - Two Diameters Reducing Lead Off Square to Round Mitre Joints	2 hrs.
Describe brazing and determine when it is appropriate to use this process in the joining of metals.	Brazing and Braze Welding	2 hrs.
Describe fusion welding and recommend appropriate application.	Fusion Welding	2 hrs.
Braze using oxy-acetylene and carbon arc equipment in the down-hand position.	The Carbon Arc Process Weld Flat Stock Steel Horizontal Vertical Corner Weld Lap Weld Edge Weld Patch Holes Braze Copper Tubes Braze Cast Iron Silver Solder	6-8 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the theory of the arc-welding process and set up welder for various welding jobs, selecting proper filler.	Arc Welding Techniques	6 hrs.
	Set Up Equipment	
	AC	
	DC	
	Safety	
	Regulate Machines	
	Prepare Work	2 hrs.
	Cut-Bevel	
	Clean	
	Weld	2 hrs.
	Single Bead - Flat	
	Fillet Weld	
	Butt Weld	
	Lap Weld	
	Vertical	
	Build Up Cast Iron and Steel	
	Overlay and Lace Bead	
	Horizontal T and Fillet	
	Low Pressure Piping	
Describe the uneven expansion and contraction of metals and recommend practices to offset this phenomenon.	Pre-Heating	1 hr.
	Spot Welding	1 hr.
Cut with torch.	Oxy-Acetylene Torch Use	4 hrs.
	Cutting Tip	

SUGGESTED PROCEDURE:

1. Visit a welding shop or class.

2. Utilize a guest lecturer to give demonstrations of welding techniques.

ACKNOWLEDGEMENTS:

Central Illinois Public Service Company, Springfield, Illinois.

TITLE: Electrical Parameters II

EDUCATIONAL BLOCK 0.14.b

NOTES: Electronic slide rule type calculation aides are available at a nominal cost from several of the major manufacturers that do a good job of relieving the student from much of the calculating type activities involved here.

REFERENCES:
1. Devito, M. Introduction to Electricity-Electronics.
2. Grob, Bernard. Basic Electronics.
3. Malvino, Albert P. Electronic Principles.
4. Zbar, Paul B. Basic Electricity.

GENERAL OBJECTIVE: Define and describe the electrical parameters in circuits containing capacitance and inductance, determining desired unknowns from given quantities.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define and characterize capacitance.	Capacitance	10 hrs.
	Capacitance as Ability to Store Energy in Electric Field	
	Characteristics of Capacitance	
	Opposition to Change in Voltage	
	Storage of Charge	
	Block DC	
	Pass AC	
	Capacitance in Series	
	Capacitance in Parallel	
	Unit of Capacitance	
	µFarad	
	pFarad	
	Symbols for Capacitance	
Determine electric parameters in circuits containing capacitance.	Capacitive Reactance	5 hrs.
	Impedance	
	Phase Angle	
	Power Factor	
	Time Constant	
Define and characterize inductance.	Inductance	10 hrs.
	Inductance as Ability to Store Energy in Magnetic Field	
	Characteristics of Inductance	
	Opposition to Change in Current	
	Block AC	
	Pass DC	
	Inductance in Series	
	Inductance in Parallel	
	Unit of Inductance	
	Henries	
	mHenries	
	µHenries	
	Symbols for Inductance	

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Determine electric parameters in circuits containing inductance.	Inductive Reactance Impedance Phase Angle Power Factor Time Constant	5 hrs.
Define, describe, and determine frequency in resonant circuits.	Resonance Series Resonance Parallel Resonance	4 hrs.
Characterize transformers and determine turns and impedance ratio relationships.	Transformers Power Step Up Step Down Multiple Secondary Coupling Matching Taps	4 hrs.

SUGGESTED PROCEDURE:

1. If the mathematics background of student group precludes the use of algebra in the solution of the following equations for desired unknowns, it is recommended that the use of nomographs such as those found in Appendix be used.

$$TC = \frac{L}{R}, \qquad TC = R \times C$$

$$Xc = \frac{1}{2\pi FC}, \quad X_L = 2\pi FL, \quad Z = \sqrt{R^2 + X^2}, \quad \text{TAN}\,\theta = \frac{X}{R}$$

$$\text{P.F.} = \text{Cos}\,\theta, \quad F_r = \frac{1}{2\pi\sqrt{LC}}, \quad \frac{N_s}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is} = \frac{\sqrt{Zs}}{\sqrt{Zp}}$$

$$C\text{ eq (series)} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}, \quad L\text{ eq (series)} = L_1 + L_2$$

$$C\text{ eq (parallel)} = C_1 + C_2 \qquad L\text{ eq (parallel)} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2}}$$

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electronic Circuit Fundamentals

EDUCATIONAL BLOCK 0.18

NOTES:

1. It should be noted that the emphasis in this block is on the function of these circuits, i.e. on the signal processing accomplished by each circuit with a complete disregard on how each circuit works internally and the circuit elements included.

2. The instructor should choose which circuits in this to treat, on the basis of which of the circuits are used in systems available for student use.

3. Total time allotment for this block should not exceed 20 hours (or 1/2 hour per circuit).

REFERENCES:

1. Churchman, L. Survey of Electronics.
2. Sands, Leo G. Electronics Handbook for the Electrician.

GENERAL OBJECTIVE: The student will identify the primary function(s) and applications of common electronic circuits typically encountered in electronic systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and describe the function of the listed circuits in terms of the signal processing accomplished by each unit.	Rectifiers	
	Filters	
	Tuned Tank Circuits	
	Power Supplies	
	Voltage Regulators	
	Current Regulators	
	Voltage Doublers	
	Amplifiers	
	Voltage	
	Power	
	Tuned	
	Differential	
	Voltage Followers	
	Oscillators	
	Multivibrators	
	Limiters	
	Clippers	
	Clampers	
	Triggers	
	Detectors	
	Demodulators	
	Modulators	
	Mixers	
	Bridges	
	Sync Circuits	
	Logic Circuits	
	And/Nand	
	Or/Nor	
	Flip-Flops	
	Adders	
	Counters	
	Sweep Circuits	
	Frequency Dividers	
	AFC	
	AVC	

SUGGESTED PROCEDURE:

1. These circuits should be treated on a black-box basis. Selected circuits can be built up in boxes so that the student can relate them to a block diagram and interconnect them so as to do a sequence of signal processing to create a desired system output. If it is difficult to build up or purchase these units in quantity for student use, single units should be constructed so that they may be used for demonstration purposes.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Drawings and Specifications (Electronics)

EDUCATIONAL BLOCK I.11.b

NOTES: Because of the preponderance of specialized terminology, abbreviations, and acronyms in the field of electronics, these should be given special emphasis throughout any program in electronics.

REFERENCES:
1. Baer, Charles J. Electrical and Electronics Drawing.
2. Middleton, Robert G. Electrical and Electronic Signs and Symbols.
3. Radio Shack Electronics Data Handbook.
4. Radio Shack Electronics Dictionary.
5. Shiers, George. Electronic Drafting.

GENERAL OBJECTIVE: Read and interpret conventional drawings, schematics, and specifications encountered on the job.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and describe conventional types of drawings, diagrams, graphs and charts typically encountered in electronics.	Types of Drawings Block Diagrams Functional Diagrams Schematics Wiring Diagrams Component Layout Circuit Pattern Truth Tables Graphs and Charts Bar and Pie Charts Volt-Ampere Graphs Characteristic Curves Nomographs	8 hrs.
Read and use standard electronic symbols. Know that variations do exist from industry to industry.	Symbols - See Appendix	2 hrs.
Read and interpret standard electronic terminology, abbreviations, and acronyms.	Glossary of Electronics Terms	Continuous
Read and interpret standard drawings, diagrams and charts used in electronics.	Conventions of Electronics Drawings Lines Lettering Title Blocks Notes Dates and Revisions Bill of Materials Model and Serial Number Sequence of Signal Operations Mechanical Linkages Component Values Horizontal Signal Flow Vertical Power Flow	4 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Ground or Common at Bottom Labeling of Test Points, Pin Locations, etc. Symmetry	
Identify and describe standard types of specifications encountered in the electronics industry.	Specifications Types of Specifications Design Operating Performance	1 hr.
Define conventional specifications for electronics equipment.	Specifications Content Input Current Voltage Power Ripple Frequency Sensitivity Selectivity Output Current Voltage Power Frequency Response Waveshape Gain Stability Separation Level Accuracy Precision Environmental Temperature Vibration Humidity Shock Accelleration Mounting Specifications	4 hrs.
Draw sketches of electronic circuits and systems using conventional practices.	Sketching	10 hrs.
Locate replacement parts using catalogs from suppliers.	Catalog Usage with Typical Examples	1 hr.

SUGGESTED PROCEDURE:

1. The instructor should obtain a wide assortment of different types of drawings, diagrams, specification sheets, etc. so that the students get as wide an exposure to the various types as possible.

2. The student should secure a good glossary or dictionary of electronic terminology, available from several parts houses. Further, he needs at this point a diagram of typical symbols used in electronics. See Appendix.

3. Building an electronic ket or project would help illustrate this material. Caution: The kit should take a minimal amount of time.

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electronic Troubleshooting I

EDUCATIONAL BLOCK 0.20.a

NOTES: This block may be covered concurrently with Block 0.18, Electronic Circuit Fundamentals and Block I.11.b, Electronic Drawings and Specifications.

REFERENCES:
1. Lemons, Wayne. Learn Electronics Through Troubleshooting.
2. Smith, Paul C. Know Your Oscilloscope.
3. Zbar, Paul B. Electronics Instruments and Measurements.

GENERAL OBJECTIVE: Troubleshoot electronic systems to isolate fault to circuit, functional block, or module.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Use the block diagrams and schematics as troubleshooting guides.	Total System Function Contribution of Each Circuit to Total System Function Sequence of Signal Processing Test Points Voltage Waveform	10 hrs.
Isolate fault in system to functional unit or circuit.	Identification of Symptom Total Malfunction Partial Malfunction Elimination of Functioning Units Sequential Testing Signal Injection Signal Tracing Test Point Checking Voltages Waveforms Module Substitution	10 hrs.

SUGGESTED PROCEDURE:

1. The student should be presented with faulty (bugged) electronic systems along with the block or schematic diagrams to troubleshoot, beginning with simple systems, progressing to more complex systems. The specific systems used are not listed as the techniques of troubleshooting are common to most systems. The following is given as a typical sequence:
    1. P. A. Amplifier
    2. Stereo Amplifier
    3. AM Receiver
    4. FM Receiver
    5. FM Stereo Tuner
    6. AM-FM Stereo Receiver
    7. Television B & W Receiver
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electric Troubleshooting II

EDUCATIONAL BLOCK I.20.b

NOTES: 1. This block should be preceded by Block I.19.a and I.19.b as the use of basic instruments is assumed.

2. The tests outlined are out of circuit tests.

REFERENCES:
1. Instruction Books for Available Tube and Transistor Checkers.
2. RCA Transistor Manual.
3. RCA Tube Manual.

GENERAL OBJECTIVE: Locate and identify common faults of electric and electronic components typically found in electric and electronic systems and circuits.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Set the proper test instrument and locate typical faults in diodes.	Diodes Faults Heater Opens or Shorts Anode to Cathode Shorts Low Front to Back Ratio Anode-Cathode Opens Breakdown	2 hrs.
Select the proper test instrument and locate typical faults in vacuum tubes.	Vacuum Tubes Filament Open Poor Emission Low gm Element Shorts Gas Noise Microphonics Tube Testers	6 hrs.
Select the proper test instrument and locate typical faults in semiconductor devices	Semiconductors Shorts Opens Low Front to Back Ratio Low Beta Leakage Transistor Checkers Low Gain	8 hrs.
Select the proper test instrument and locate faults in sensors and transducers.	Sensors and Transducers	2 hrs.

SUGGESTED PROCEDURE:

1. The instructor should have on hand a supply of faulty components that reflect listed faults so that the student can evaluate and troubleshoot each.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electronic Troubleshooting II

EDUCATIONAL BLOCK 0.20.b

NOTES:
1. This block should be preceded by Block 0.20.a.

2. The instructor should select circuits to treat from list as in Block 0.18.

REFERENCES:
1. Lemons, Wayne. Elements of Radio Servicing.
2. Lemons, Wayne. Learn Electronics Through Troubleshooting.

GENERAL OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define the function of each component in typical electronic circuits.	Review of Block 0.17 (Functions of Components)	4 hrs.
	Internal Operation of Typical Electronic Circuits	20 hrs.
	Rectifiers	
	Filters	
	Differentiators/Integrators	
	Tuned Circuits	
	Power Supplies	
	Regulators	
	Voltage Doublers	
	Amplifiers	
	Oscillators and Multivibrators	
	Limiters and Clippers	
	Clampers	
	Triggers	
	Detectors and Demodulators	
	Modulators	
	Mixers	
	Bridges	
	Sync Circuits	
	Logic Circuits	
	Sweep Circuits	
	Miscellaneous Circuits	
Locate faulty components in electronic circuits following logical troubleshooting procedures.	Troubleshooting	12 hrs.
	Isolation of Fault to Circuit or Module (Block 0.20.a)	
	Visual Inspection	
	Smoke	
	Heat	
	Voltage Measurements	
	Current Measurements	
	Resistance Measurements	
	Signal Tracing	
	Waveform Checking	
	Tube and Transistor Checking	
	Component Substitution	
	Use of Freeze Sprays	
	Use of Heat Gun	
	Use of Cleaners	
Remove faulty component, secure replacement and install replacement or substitute.	Desoldering	4 hrs.
	Sources of Replacement	
	Substitute Components	
	Soldering	

SUGGESTED PROCEDURES:

1. The instructor should have stock of bugged circuits for students to begin troubleshooting. Later in sequence faulty units can be solicited for student repair.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

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TITLE: Tools III (Electronic) EDUCATIONAL BLOCK 0.13.c

NOTES: 1. Some of these tools may be used by the electrician.

2. The usage of these tools can best be illustrated when teaching the skills which require them.

3. Time does not include student usage.

REFERENCES: Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Select and use the correct electronics hand and power tools.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Properly use common hand tools in making electrical connections.	Wire Strippers Knives Crimpers Wire Wrappers	1 hr.
Select and use specialized tools used in electrical, electronic equipment maintenance and repair.	File Card Board Extenders Alignment Tools Gozinta Air Hoses Vacuum Cleaners Tape Head Cleaners Test Clips	2 hrs.
Identify common electronic hardware.	Grommets Standoffs Rubber Feet Terminals Terminal Strips Silicone Compounds Potting Adhesive Greases Knobs Plugs, Jacks and Binding Posts Coaxial Connectors Printed Circuit Connectors	2 hrs.

SUGGESTED PROCEDURE:

1. Use illustrations to show the physical characteristics of the tool.

2. Use the tools when demonstrating the applicable skills.

3. Use electronic parts catalogs. Typical catalogs are:
   Newark Electronics, Chicago, Illinois
   Allied Electronics, Elgin, Illinois

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements III

EDUCATIONAL BLOCK 0.19.a

NOTES: Instruments and Measurements (I.19.a) is a prerequisite to this block. The topics covered in this block might best be covered as needed rather than as a block in itself.

REFERENCES:
1. Manufacturer's Instruction Manuals
2. Training and Retraining, Inc. Understanding and Using Test Instruments.

GENERAL OBJECTIVE: Select, use properly, and care for instruments and test equipment used in troubleshooting electronic systems.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of signal generators (both AF & RF), signal tracers, capacitor checkers, transistor testers, logic probes and test jigs and fixtures.	Instrument Characteristics Capabilities of Each Accuracy Reading Scales Sensitivity Care of Instruments Calibration	4 hrs.
Apply and trace a signal through an electronic system with the equipment listed.	Signal Generators Audio Frequency Radio Frequency Sweep Generators	2 hrs.
Determine the condition of transistors, vacuum tubes, and integrated circuits found in electronic systems.	Transistor Testers Tube Testers IC Checkers Logic Probes	2 hrs.
Identify bad or leaky capacitors, inductors, and determine their value with maximum accuracy.	Capacitor Checkers Bridges	1 hr.
Properly use special test jigs and fixtures in evaluating electronic system components.	Test Jigs and Fixtures Extender Boards Special Extender Cables Soldering Fixtures	1 hr.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Use equipment manuals. Typical manufacturers are:
   Henlett Packard, Palo Alto, California.
   Tektronix, Beaverton, Oregon.
   Sencore Inc., Soux Falls, South Dakota.

TITLE: Lineman Skills

EDUCATIONAL BLOCK I.51

NOTES:

1. The following skills are peculiar to lineman and will be difficult to implement because of the large sizes involved. However, a less than "actual hardware" approach can be used by utilizing some of the excellent software available (listed herein) and scaled models.
2. The skills listed below are those required of a beginning lineman.
3. Time does not include actual student practice.
4. It is assumed that the instructor would be covering power and communication lineman skills separately.

REFERENCES:

1. Edison Electric Institute. Agriculture Wiring Handbook.
2. Kurtz, Edwin B. and Shoemaker, Thomas M. The Lineman's and Cableman's Handbook.
3. Ohio Trade and Industrial Education Service. Electrical Lineman.

GENERAL OBJECTIVE: Perform those skills peculiar to the lineman.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Dig a hole for poles and anchors in rocky, sandy, clay or common soil using hand or power diggers.	Pole and Anchor Holes Shovels Straight Spoon Digger	2 hrs.
Unload poles from a flat car.	Hand Augar	5 hrs.
	Power Augar	5 hrs.
Load, unload and haul poles with a pole trailer.	Tools, Hand and Power See Block I.53	
Set a pole. Frame a pole.	Pole Equipment Pole Spikes Pole Grabber	1 hr.
Plumb and tamp a pole. Install a pole key. Rake a pole.	Poles Class Size Cars Trailer Piles Pole Keys Guys Gin Pole Rake Push Pole	2 hrs.
Install guy wire and anchors.	Anchors Expanding Screw Log Plate Rock	2 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Connect the equipment listed.	Equipment Transformers Lighting Arrestors Switches Regulators	8 hrs.
Use hand lines for lowering and raising tools and equipment.	Framing Cross Arms Braces Insulators	2 hrs.
Use hand signals in position equipment.	Hand Lines and Tool Bags	5 hrs.
Load, unload and unstring large, heavy loads of wire and cable from pole to pole.	Wire and Cable Reels Size Weight Types CWC ACSR Movable Reels Stationary Reels	2 hrs.
Read a watt-hour meter.	Wire Splices Twist Sleeves Compression CWC Twist Performed	4 hrs.
Cut down and trim trees.	Safety Equipment Rubber Goods Hot Sticks Leather Goods Testing	2 hrs.
Operate a wood chipper for disposing of brush.	Meters Installations Reading Type	1 hr.
Pull Poles.	Hand Signals	5 hrs.
Climb poles, enter tunnels, buildings, trenches, crawl spaces or manholes to place material.	Relay Stations Repeater Stations Substations	1 hr.
Identify and know the function of underground wiring and cable.	Underground Wire and Cable Power Communication	4 hrs.
Identify and know the function of underground installations.	Direct Burial Conduit	4 hrs.
Identify and know the function of test equipment used to detect for gas in underground installations.	Gas Detectors	1 hr.
Identify and know the existance of other underground installations to be avoided.	Gas Water	1 hr.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and know the function of underground service drops.	Services Residential Commercial Power Communication	2 hrs.
Identify and know the purpose and function of transits.	Transit Leveling Sighting	2 hrs.
SPLICE CABLES (Communication Lineman Only)		
Splice multiwire cables. Terminate wires with or attach to terminals.	Cables Wire Coax Size Number of Conduction	2 hrs.
SWITCHING (Power Lineman Only)		
Energize and de-energize lines. Operate substations. Operate street lights. Switch high voltage lines.	Switching Sectional Substation Disconnect	2 hrs.
Perform transformer polarity tests.	Polarity Test	1 hr.
SPLICE CONDUCTORS (Power Lineman Only)		
Prepare each end of the conductors by trimming with a knife or wire stripper.	Conductors Type Sizes Material Insulation	1 hr.
Clean the stripped wire with steel wool or wire brush.	Sleeves (Compression) Aluminum (ACSR) Copper Sizes Split Bolt Connectors	1 hr.
Connect splice to each conductor by wrapping, sodering or compression.	Compression Tools (See Block I.53) Hand Hydraulic	2 hrs.
Apply splice protector or insulating coating.	Sleeve (Twisted) ACSR Preformed	
	Sleeve Wrenches (See Block I.53)	1 hr.

SUGGESTED PROCEDURE:

1. See the Ohio reference listed under References.

2. Small scale mockups are available of poles, lines and equipment.

3. Examples of wire, splices, meters, etc. are available from local utilities as well as installation specifications.

4. Equipment catalogs are also available which can yield useful illustrations.

5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Tools IV (Lineman)   EDUCATIONAL BLOCK I.53

NOTES: 1. The following tools are peculiar to the lineman skills and are highly specialized. Instructor discretion will be required in deciding what tools to be covered as well as whether they apply to power or communication. Many are listed graphically in the Ohio Reference.

2. Time does not include student usage.

REFERENCES: Ohio Trade and Industrial Education Service. Electric Lineman.

GENERAL OBJECTIVE: Properly use and care for tools typically used by the electrical lineman for the purposes listed.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and know the proper use and care for tools used to handle poles.	Log Binder Pole Binder Log Chain Wedge Clamp Carrying Hook	2 hrs.
Identify and know the proper use and care for tools used to dig holes for poles and anchors.	Transit Surveying Tape Anchor Auger Digging Bar Two Handle Digger Jack Hammer Sledge Hammer Picks	2 hrs.
Identify and know the proper use and care for tools used to frame poles.	Framing Gin Draw Knife Drift Pin Saws	2 hrs.
Identify and know the proper use and care for tools used to set, remove or streighten poles.	Bump Board Blocks Pole Hoist Chain Hoist Cant Hook Pole Jack Plumb Bob Anchor Ram Pick Pole Tamps (Hand, Air, Hydraulic) Pole Jenny Level Ground Rod Driver	2 hrs.
Identify and know the proper use and care for tools and equipment used to climb poles.	Bolt and Nut Bag Body Belt Climbers	2 hrs.

Tools IV (Lineman)
I.53

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and know the proper use and care for tools and equipment used to install and tie in conductors.	Material Bag Conductor Cleaning Brush Dynamometer Insulated Gin Lifting Gin Pulling Grip Wire Grip Reel Jack Skinning Knife Taglines Payout Reels Takeup Reels Rope Slings Rubber Sleeve Splicing Clamp Armor Rod Wrenches Sleeve Wrench Compression Wrench Diving Board	2 hrs.
Identify and know the proper use and care for tools used to move or repair energized lines.	Rubber Blanket Rubber Gloves Rubber Protectors Jumpers Fuse Puller Clamp Sticks Fuse Sticks Hot Line Tools Grounding Saddle	2 hrs.
Identify and know the proper use and care for common lineman hand tools and equipment.	Lineman Hammer Safety Hat Lineman Pliers Slipjoint Pliers Wedges Gaff Gauge Trouble Light Portable Generator	2 hrs.
Identify and know the proper use and care for tools used to install and repair pipe and conduit.	Hack Saw Pipe Bender Pipe Reamer Pipe Threader	2 hrs.
Identify and know the proper use and care for brush clearing tools.	Brush Hook Hand Trimmer Power Trimmer Chipper	2 hrs.

SUGGESTED PROCEDURE:

1. This sequence may best be run concurrently with the Lineman Skills Block I.51, so that each tool is treated as it is needed.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Install Service and Meters

EDUCATIONAL BLOCK I.27

NOTES: Time does not include student practice.

REFERENCES:
1. Alerich, Walter N. Electrical Construction Wiring.
2. Kurtz, Edwin B. and Shoemaker, Thomas M. The Lineman's and Cableman's Handbook.
3. Ohio Trade and Industrial Education Service. Electrical Lineman.

GENERAL OBJECTIVE: The student will install residential, commercial and industrial service.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Verify and locate service location as defined by work order.	House Brackets Single Phase Three Phase	1 hr.
Install wire support brackets on masonry and wood surfaces. Install service rack or service assembly on pole. String, fasten and sag service wires between pole and customer rack.	Service Cable Single Phase Three Phase Weight Capacity Voltage Current Pay Out Reel	6 hrs.
Connect service conductors to transformers secondary. Connect and disconnect transformers using a hot stick.	Transformer Disconnect Line Connections Ground Connections	4 hrs.
Dig and fill trench from pole or surface to ground rod. Start and drive ground rod into soil using hammer, tongs and ground rod driver.	Ground Rods Sizes Length Diameter Clamps Installation	2 hrs.
Install ground wire from ground rod to the pole in a trench and up the pole to the ground connection.	Installation Hardware Ground Rod Protector Ground Rod Clamp Staples	1 hr.
Connect the ground wire to the ground rod using a ground rod clamp.	Installation Specifications Trench Rod Attach to Pole Connect Splice	1 hr.

Install Service and Meters
I.27

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Splice and connect the ground wire to the pole ground.	Ground Wire Types Sizes	1 hr.
Verify meter base is installed in accordance with company specifications.	Meter Base Type Mounting Level	4 hrs.
Perform pre-installation tests: a. Cross check meter and meter base. b. Check voltage with a voltmeter. c. Install meter in meter base and seal around meter. d. Turn on the load and check meter for proper rotation.	Meter Two Wire Three Wire Indoor Outdoor Socket Size Voltage Ampeers Wheel	4 hrs.
Read and record meter readings and location date.	Meter Dials Types How to Read	4 hrs.
	Installation Date Date Set Serial Number Location Initial Reading	2 hrs.

SUGGESTED PROCEDURE:

1. Use pictures, slides etc. of typical installations.

TITLE: Install and Read Recording Instruments

EDUCATIONAL BLOCK I.31

NOTES: This block is intended for electric utility workers and instrument technician. The instructor must decide which areas are to be covered.

REFERENCES:
1. Howard Sams Technical Staff, ed. Instrumentation Training Course.
2. Ohio Trade and Industrial Education Service. Electric Lineman.
3. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Install, connect and read time recordings of voltage, current, power and other electrical parameters.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Connect magnetic tape recording meters to single and three phase circuits.	Magnetic Recorders Power Input Input Connections Tape	4 hrs.
Set up and operate magnetic tape recording meters.	Reels Drive Mechanism Speed Setting	
Load and unload magnetic tape recording meters.		
Connect chart recording meters to single and three phase circuits.	Chart Recorders Circular Power Input Input Connections	2 hrs.
Set up and operate chart recording meters.	Charts Types Layout	2 hrs.
Load and unload charts.	Speed Setting	1 hr.
Connect recorders to measure voltage or current.		2 hrs.

Install and Read Recording Instruments
I.31

SUGGESTED PROCEDURE:

1. Demonstrate recorder connection, set up, and calibration.
2. Obtain catalogs from recorder manufacturers. Typical manufacturers are: Bell and Howell Co., Pasedena, California; Ampex, Redwood City, California; and Teletype Corp., Skokie, Illinois.
3. Visit a laboratory or control room for some industrial process such as electric utility, water utility, chemical laboratory, etc.
4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

ACKNOWLEDGEMENTS:

Robert Billing, Illinois Public Service Co., Champaign, Illinois.

TITLE: Meter Repairman Skills

EDUCATIONAL BLOCK I.32

NOTES: Meter repairman is intended to include those skills not common to other utility occupations and specifically for those occupations related to customer or field metering.

REFERENCES: Ohio Trade and Industrial Education Service. Electric Lineman.

GENERAL OBJECTIVE: Perform those skills peculiar to the electric meter repairman.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Pre-wire single and polyphase meter cabinets.	Meter Cabinets Size Capacity Manufacturer's (types)	4 hrs.
Identify and know the uses of current and potential transformers. Make connections between current transformers, doughnuts and potential transformers and metering cabinet.	Instrument Transformers Turns Ratio (Primary/ Secondary) Voltage (Potential) Transformer Current Transformer Core Insulation Types	4 hrs.
Make a ratio check of CT and PT to insure proper meter reading.	Ratio Check Method Standard Comparison of Primary and Secondary Readings	1 hr.
Adjust and calibrate meters. Reset demand indicator and reset arm.	Meters Definition Wattmeter Watt Hour Meter Demand Watt Meter	4 hrs.
Maintain meter files.	Files Equipment Records Test Records Instruction Files	2 hrs.

SUGGESTED PROCEDURE:

1. See Reference.
2. Obtain old meters and meter bases for demonstration.
3. Use equipment catalogs as resource material.
4. Contact local power companies for assistance.

ACKNOWLEDGEMENTS:

Central Illinois Public Service Company, Springfield, Illinois.

TITLE: Locomotive Electrician Skills

EDUCATIONAL BLOCK 1.22

NOTES: The following skills are peculiar to locomotive electrician and would be difficult to implement if not impossible because of the equipment involved. These skills would be acquired in on-the-job training.

REFERENCES: Illinois Central Gulf Railroad Training and Development Program. Chicago, Illinois, and Baton Rouge, Louisiana.

GENERAL OBJECTIVE: The student shall perform those skills peculiar to the locomotive electrician.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Perform necessary adjustments on locomotive circuits as specified in the outline.	Electrical Adjustments IRC Load Regulator Protective Circuits Headlight Resistors Wheel Slip Relays	OJT
Perform the necessary locomotive and car body circuit checks as specified in the outline.	Circuits COR Traction Motor Hookup Wheel Slip Field Shunting Automatic Sanding Lighting Car Heaters Water Cooler Trainline	OJT
Perform the necessary locomotive and car body electrical tests as specified in the outline.	Tests High Voltage Cabinet High Voltage Leads Traction Motors Armatures Generator Transition Radio Protective Circuits	OJT
Install and connect electrical and electronic equipment in locomotive and cars as specified in the outline.	Installation Radios Generators Auxiliary High Voltage Parts Battery Conduit D14 Alternator	OJT
Overhaul and/or repair locomotive and car electrical equipment.	Overhaul Motors Generators Throttle Stand Relays and Contactors Regulators Brush Holders Pneumatic Reservoirs Control Panels Air Conditioners	OJT

SUGGESTED PROCEDURE:

1. These are very special skills and extensive planning and consulting is necessary. This help could be obtained from railroads.

TITLE: Electrolysis Tester Skills

EDUCATIONAL BLOCK I.60

NOTES: Many of these skills and tests are beyond the scope of high school and could be considered on-the-job training.

GENERAL OBJECTIVE: Perform electrolysis testing and maintenance.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Perform electrolysis tests on cables, tanks, pipes and cathodic protective installations in manholes, ducts, substations and garages.	Electrolysis Testing Tanks Pipes Cables Rails Specifications	8 hrs.
Set up and properly connect electrical equipment.	High and Low Ohm Voltmeters DC Ammeters One and Four Rod Soil Resistance Measuring Instruments Copper Sulfate Cells	4 hrs.
Collect and label soil samples.	Procedure Containers	2 hrs.
Locate trolley laterals, substation getaway rail taps; estimate and determine proper placement and set up of measuring equipment.	Laterals Rail Taps	2 hrs. 2 hrs.

SUGGESTED PROCEDURE:

1. These are very special tests and extensive planning and consulting is necessary. This help can be obtained from pipe line companies, communication companies, railroads and transit authorities.

TITLE: Motor Repair and Overhaul

EDUCATIONAL BLOCK I.23

NOTES: 1. The scope of this block is all rotating devices up to 100 h.p. or as handling capabilities will allow, i.e., machines requiring special handling equipment should not be covered.

2. This block can be done in conjunction with Block I.12 and I.13.

REFERENCES:
1. Adams, James E. Electrical Principles and Practices.
2. A Guide to the Care of Electrical Motors.
3. Anderson, Edwin P. Electric Motor Guide.
4. Lytel, Allan H. ABC's of Electric Motors and Generators.
5. Mages, Loren J. Electric Generating Systems.
6. Rosenberg, Robert. Electric Motor Repair.
7. Schweitzer. Fractional Horsepower Motors and Repair.
8. Smeaton, Robert. Motor Application and Maintenance Handbook.

GENERAL OBJECTIVE: Overhaul, rebuild and repair rotating electrical devices.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Check, lubricate and/or replace bearings.	Bearings	2 hrs.
	Roll	
	Sleeve	
	Ball	
	Rotor Shafts	
	End Plates	
	Lubricants	
	Oils	
	Greases	
	Method of Applying Oil or Grease	
Replace Brushes.	Brushes	2 hrs.
	Function	
	Motors That Use Brushes	
	Grades	
	Sizes	
	Shades	
	Material	
Replace or adjust centrifugal switches.	Centrifugal Switches	2 hrs.
	Function	
	Motors That Use Switches	
	Sizes	
	Types	
	Ratings	
	Location	
Rewind stator, rotor and field windings.	See Reference #6, Electric Motor Repair	8 hrs.
Test pole piece polarities.	Pole Piece Polarities	1 hr.
	Function	
	Types of Tests	

Motor Repair and Overhaul
I.23

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Balance rotors and reassemble motor with proper end loading or end play.	Bearings End Plates	4 hrs.
Test windings, components and connections for shorts, grounds and opens.	Visual Inspection Resistance Readings Test Points Ohms Intermittant	2 hrs.
Replace defective parts such as wire, capacitors, connectors and cables.	Wire Types Coils Insulation Mounting Capacitors Type Oil Electroyltic Function	4 hrs.
Repair and adjust small motors.	Small Motors Types Vibrating Printed Circuit Stepping Universal	4 hrs.
Use motor test equipment and tools listed in the outline.	Growler Internal External Test Light Coil Winders Compass Undercutter	4 hrs.

SUGGESTED PROCEDURE:

1. Obtain and use faulty motors for the students to practice their trouble-shooting techniques.
2. Use motors to demonstrate repairing and lubricating techniques.
3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

ACKNOWLEDGEMENTS:

Doran Hershberger, General Electric, DeKalb, Illinois.

TITLE: Instruments and Measurements IV

EDUCATIONAL BLOCK 0.19.b

NOTES: Prerequisite to this block are Blocks I.19.a, and 0.19.a.

REFERENCES:
1. Lemons, Wayne. Transistor Radio Servicing Course.
2. Manufacturer's Instruction Manuals.
3. Shrader, Robert L. Electronic Communication.
4. Zbar, Paul B. Basic Radio: Theory and Servicing.

GENERAL OBJECTIVE: Select, use properly and care for specialized instruments used in checking, aligning, and troubleshooting radio frequency electronic systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of frequency counters, grid-dip meters, RF power meters, RF sweep generators, distortion analyzers, dummy loads, special test and calibration equipment and test jigs and fixtures.	Instrument Characteristics Capabilities of Each Accuracy Scales and Dials Loading Effects Sensitivity Care of Instruments Calibration	6 hrs.
Measure frequency of RF signals with the full accuracy and precision of the instruments listed.	Grid Dip Meters Frequency Counters Oscilloscope	3 hrs.
Measure RF power levels and SWR with the full accuracy and precision of the instruments listed.	RF Power Meters Watt Meters	1 hr.
Analyze RF Waveforms.	Distortion Analyzer	1 hr.
Align and troubleshoot RF systems by signal injection techniques.	RF Signal Generator Sweep Generators	2 hrs.
Properly use dummy loads, and special equipment in aligning and troubleshooting RF equipment.	Dummy Loads Special Test Equipment (as applies to specialized equipment) Special Calibration Equipment Test Jigs and Fixtures	4 hrs.

SUGGESTED PROCEDURES:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Demonstrate different measuring techniques.

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TITLE: Air Conditioning and Refrigeration   EDUCATIONAL BLOCK I.63

NOTES: Time permits little practical application and many of these skills could be considered on-the-job training.

REFERENCES:
1. Anderson, Edwin P. Air Conditioning.
2. Harris, Norman C. Modern Air Conditioning Practice.
3. Lang, V. Paul. Principles of Air Conditioning.
4. Schweitzer, Gerald and Ebeling, A. Basic Air Conditioning.
5. Severns, William and Fellows, Julian. Air Conditioning and Refrigeration.

GENERAL OBJECTIVE: Demonstrate knowledge of air conditioning and refrigeration equipment and test gear by properly installing, troubleshooting, and repairing faults.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Demonstrate understanding of refrigeration systems by identifying components and defining function of each.	Refrigeration Systems Refrigerants Compressors Condensors Evaporators Lines and Piping	4 hrs.
Maintain and repair typical refrigeration units.	Maintenance of Refrigeration and Air Conditioning Equipment Checking Pressures Head Pressure Suction Pressure Back Pressure Refrigerant Charging Valves Gauges Adding Refrigerants and Oils System Pumpdown Purging Systems Leak Tests Evacuating System	10 hrs.
Troubleshoot and repair electrical, electronic and pneumatic controls on refrigeration units.	Electronic Controls Limit Controls Dampers, Valves, and Relays Motor Controls AC Motors and Control Drives Pneumatic Controls	10 hrs.

SUGGESTED PROCEDURE:

1. Visit an appliance repair shop.
2. Utilize a guest lecturer to give demonstrations and/or service techniques.
3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.
4. Time will probably not allow for practical application and emphasis should be on demonstration.
5. Show pictures, slides etc. of typical installations.

TITLE: Plumbing

EDUCATIONAL BLOCK I.64

NOTES: Time permits little practical application and many of these skills could be considered in the job training.

REFERENCES:
1. Manas, Vincent. National Plumbing Code Handbook.
2. Matthias, A. J., and Smith, Estes. How to Design and Install Plumbing.
3. Oravetz, Jules, Sr. Plumbers and Pipe Fitters Library.

GENERAL OBJECTIVE: Install and connect electrical/electronic equipment that require water and waste disposal connections as well as fuel supplies

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define common terms used in plumbing and identify common plumbing system components.	Terms and Definitions	2 hrs.
Install and modify waste disposal systems.	Drainage and Waste Sizes and Types Materials Traps Ventillation Installation Modification	4 hrs.
Install and modify hot and cold water supplies.	Water Supply Sizes Materials Iron Copper Plastic Installation Modification Fixtures Valves	4 hrs.
Install and connect equipment to gas and other fuel supplies.	Gas Connection and Fittings Fuel Oil Connection and Fittings	4 hrs.

SUGGESTED PROCEDURE:

1. Visit appliance repair shops.
2. Time will probably not allow for practical application and emphasis should be on demonstration.
3. Show pictures, slides etc. of typical installations.

TITLE: Customer Relations/Job Orientation EDUCATIONAL BLOCK 0.80

NOTES: Materials covered on this topic should be included as an on-going part of any program, as well as contained within this block of specific instruction.

REFERENCES:
1. Chapman, Elwood N., Your Attitude is Showing, (Science Research Associates: Chicago, Illinois), 1972.
2. Dubin, Robert, The World of Work; Industrial Society and Human Relations, (Prentice-Hall: Englewood Cliffs, New Jersey), 1958.
3. Personal Development for Young Men, 1st ed., (Instructional Materials Laboratory, Distributive Education Department, Division of Extension, University of Texas: Austin, Texas), 1967.

GENERAL OBJECTIVE: To identify the major components of interpersonal relations in a work situation.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify the major components of a work situation	Responsibilities of his specific job Overall structure of responsibility in the organization Structure of authority in the organization	1 hour
Identify informal components of a work situation	Informal groups Cliques Persons with shared technical interests Voluntary work groups Persons with shared backgrounds and education	1 hour
Identify the components of being a member of an organization	Goals of the organization Organization's role & function in the community Individual's position within the organization Necessary work contacts Immediate supervisor Co-workers Technical advisers Persons requiring supervision	1 hour

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Anticipated relationships with persons outside of the organization Technical advisers Sources of parts & equipment Customers	
Identify appropriate work habits	Timeliness Neat appearance Pleasant demeanor	1 hour
Identify components of sound personal skills and behavior	Strong business vocabulary Descriptive words Effective speaking Pronounciation Voice tone Sincerity Poise Clarity Good personality over the phone Answering the phone Taking messages Transferring calls Giving information Speaking clearly, audibly Closing the phone conversation Good manners Positive attitude Cooperative point of view	2 hours

SUGGESTED PROCEDURE:

1. Provide the student with as much input from real-life work situations as possible: for example, arrange for visits by student groups to local businesses; bring past graduates of the school back to classroom to discuss the problems they encountered as new employees; provide talks by industrial representatives (e.g., personnel managers), from local businesses and industry on the qualities that they like to see in an employee.

TITLE: Lighting Systems

EDUCATIONAL BLOCK I.33

NOTES: Time as recommended herein does not include practical experience as outlined in the suggested procedure.

REFERENCES: Use manufacturers' equipment manuals for faders, spots, etc.

GENERAL OBJECTIVE: Install, operate and maintain live theatre lighting systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS UNIT, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:

Identify lighting systems by name, function, control and location.	Lighting Systems
	  Function
	    House
	    Stage
	  Controls
	    Operators Console
	    Stage Managers Console
	Dimmers (Faders)
	  Master
	  Individual
	  Types
	    Spot
		8 hours

Install stage lighting per specifications and in accordance with applicable codes.	Installation
	  Location
	    Portable
	    Fixed
	  Patch Panel
	    Function
	    Wiring Diagram
	  Capacity
		6 hours

Troubleshoot, repair and maintain theatre lighting systems using the techniques of Unit #15.	Lighting Systems
	  Function
	    House
	    Stage
	  Controls
	    Operators Console
	    Stage Managers Console
	Dimmers (Faders)
	  Master
	  Individual
	  Types
	    Spot
	Installation
	  Location
	    Portable
	    Fixed
	  Patch Panel
	    Function
	    Wiring
	  Capacity
		2 hours

Lighting Systems
I.33

UPON COMPLETION OF THIS UNIT, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Operate stage and house lighting systems in accordance with script, manager and action cues.	Control Panel Layout Master Switch Panic Switch Faders Gang Controls	6 hours
	Lighting Cues Script Stage Manager Action	2 hours
Maintain automatic sign equipment	Automatic signs	4 hours

SUGGESTED PROCEDURE:

1. Have the student work with or for student sponsored theatre groups. Again it should be emphasized that the student must have an appreciation for the theatre and an understanding of stage plays.
2. Practical or "hands on" experience is not included herein but would be gained by working on a school production.

TITLE: Logs and Reports EDUCATIONAL BLOCK 0.26

NOTES: The instructor should choose which section of this block is applicable to the occupation being covered. For example, the broadcast engineer may need only the material on F.C.C. logs.

REFERENCES: Pauley, Stephen. Technical Report Writing Today.

GENERAL OBJECTIVE: Keep clear, concise records of work performed and communicate this information to others using conventional methods and form.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Keep accurate records of laboratory or shop activities as performed.	Lab Notebook Dated Pages Entries Statement of Intentions Diagrams Curves, Data, Specs, Etc. Observed Data Effect of Modifications Calculations Results and Conclusions	2 hrs.
	Job Sheets Time In and Out Work Done Materials Used Cost of Materials Rates on Time Totals	4 hrs.
Communicate technical information by writing technical reports on experiments, products, design, etc., following accepted forms.	Technical Reports Specification Sheets Process Descriptions Technical Directions and Procedures	8 hrs.
Keep complete and proper logs on equipment, making appropriate entries when necessary, including broadcast, public safety and commercial radio installations.	Log Entries FCC Rules and Regulations Form of Entries When to Make Entries Who May Make Entries Correction to Entries Filling of Logs	2 hrs.

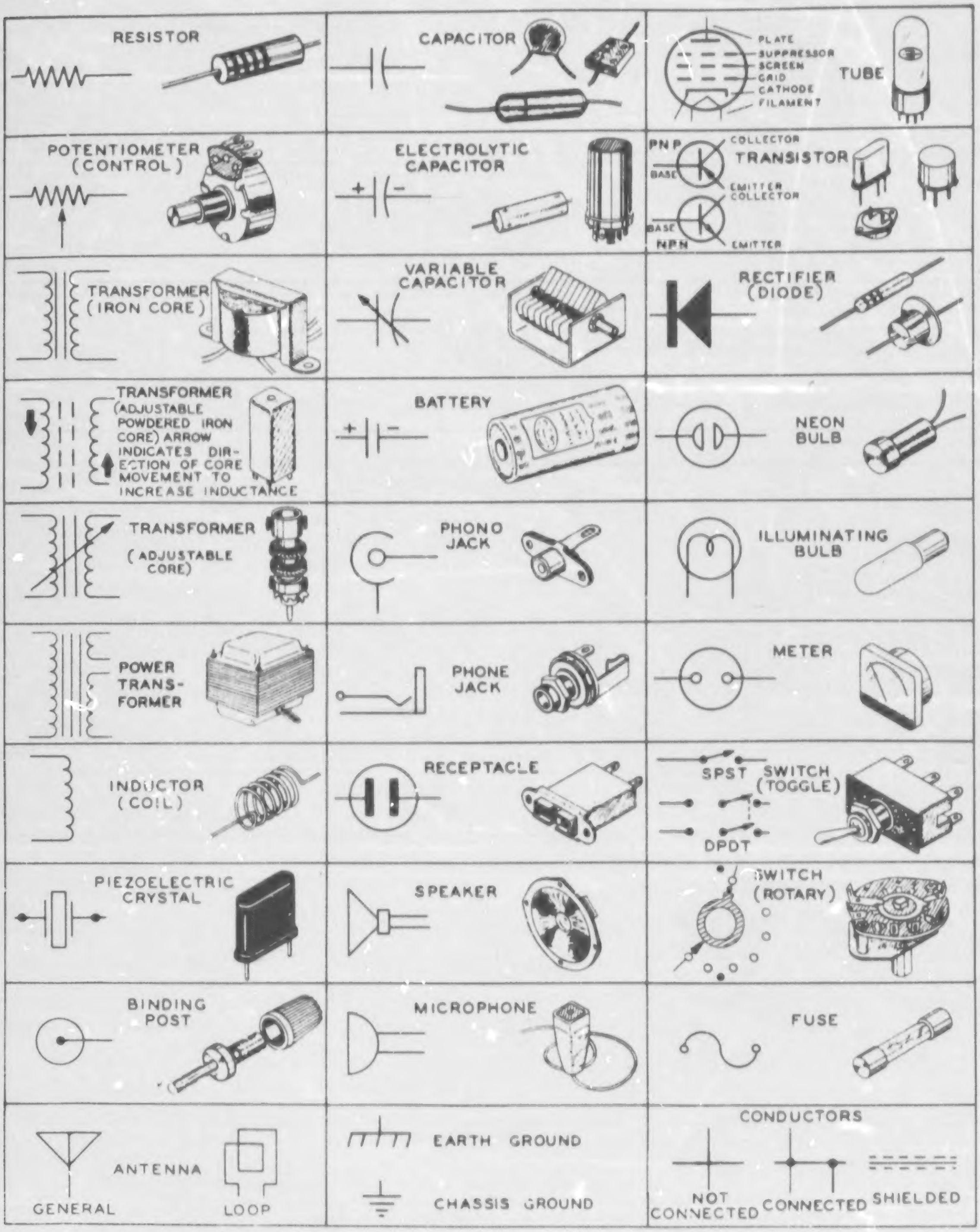
SUGGESTED PROCEDURE:

1. Use worksheets, time cards and OSHA forms such as those included in the Appendix.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.


RESISTOR
CAPACITOR
PLATE
SUPPRESSOR
SCREEN
GRID
CATHODE
FILAMENT
TUBE
POTENTIOMETER (CONTROL)
ELECTROLYTIC CAPACITOR
+
−
PNP
COLLECTOR
BASE
EMITTER
TRANSISTOR
COLLECTOR
BASE
NPN
EMITTER
TRANSFORMER (IRON CORE)
VARIABLE CAPACITOR
RECTIFIER (DIODE)
TRANSFORMER (ADJUSTABLE POWDERED IRON CORE) ARROW INDICATES DIRECTION OF CORE MOVEMENT TO INCREASE INDUCTANCE
BATTERY
+
−
NEON BULB
TRANSFORMER (ADJUSTABLE CORE)
PHONO JACK
ILLUMINATING BULB
POWER TRANSFORMER
PHONE JACK
METER
INDUCTOR (COIL)
RECEPTACLE
SPST
SWITCH (TOGGLE)
DPDT
PIEZOELECTRIC CRYSTAL
SPEAKER
SWITCH (ROTARY)
BINDING POST
MICROPHONE
FUSE
ANTENNA
GENERAL
LOOP
EARTH GROUND
CHASSIS GROUND
CONDUCTORS
NOT CONNECTED
CONNECTED
SHIELDED

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GUIDE FOR READING AND DRAWING SCHEMATIC DIAGRAMS

A SCHEMATIC DIAGRAM:

1. shows the sequence of signal operations.
2. shows the dependence of each circuit block on neighboring blocks.
3. provides a pattern for troubleshooting the system.
4. provides a method for locating the parts on the chassis.
5. shows mechanical connections, linkages, or grouping of components.
6. shows external connections.
7. shows relative importance of components.
8. shows interconnection of components.
9. tells values and limitations of the components.

RULES TO FOLLOW WHEN READING OR DRAWING SCHEMATICS:

1. Signal flows from left to right.
2. Signal components (coupling) are generally connected horizontally.
3. Power flows up or down.
4. Power components are generally connected vertically.
5. All lines are drawn either horizontally or vertically, unless specifically required by the symmetry of the circuit.
6. Ground is always at the bottom.
7. All test points, components, connections, pin locations, etc., are labeled.
8. Overall symmetry must be upheld through:
    a. evenly spaced components
    b. similar components are placed at same level on the schematic
    c. parallel construction
    d. progressive construction
9. Standard symbols and conventions are used.
10. Function and importance of components and circuits are indicated through components placement and orientation.

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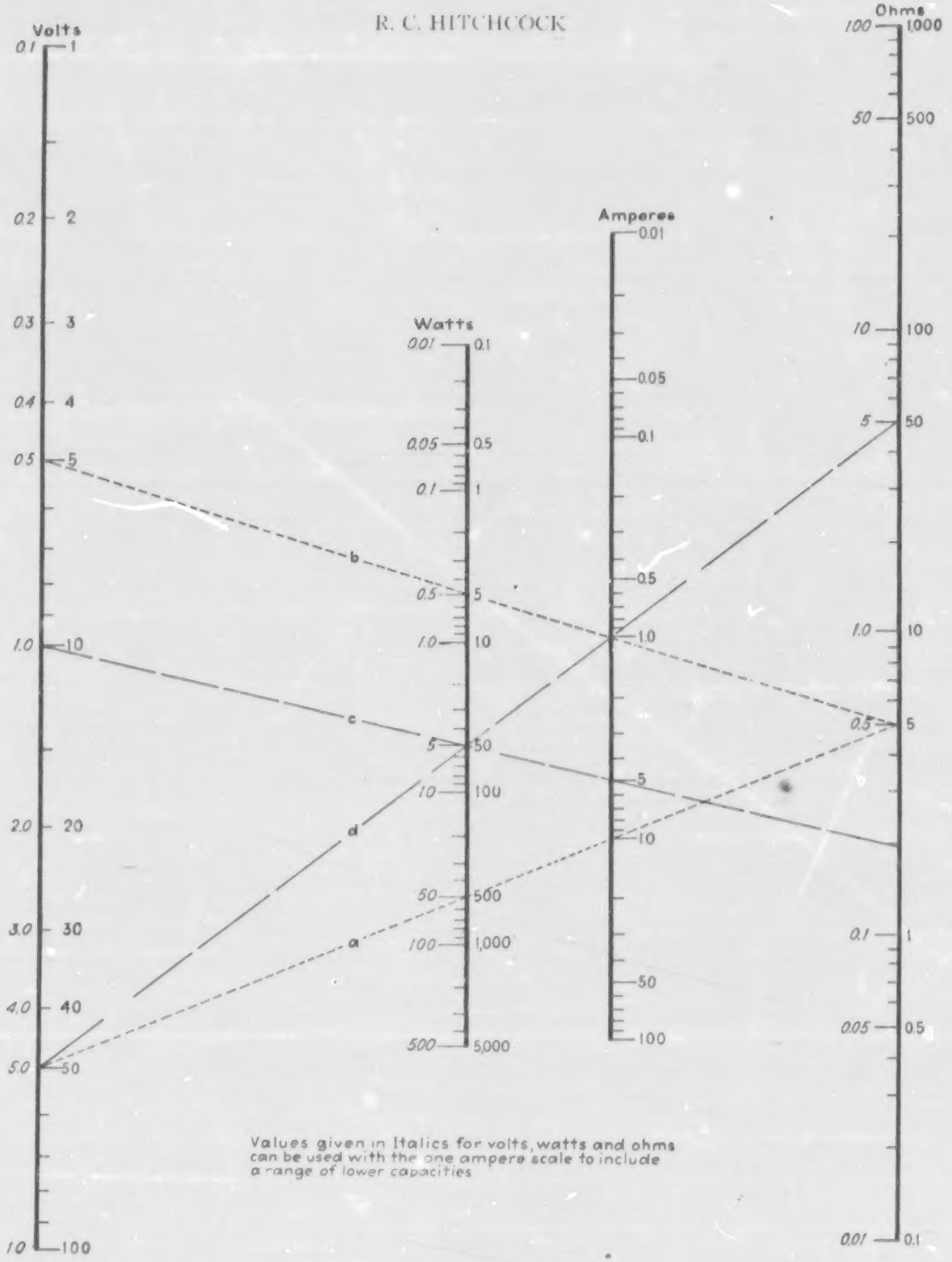
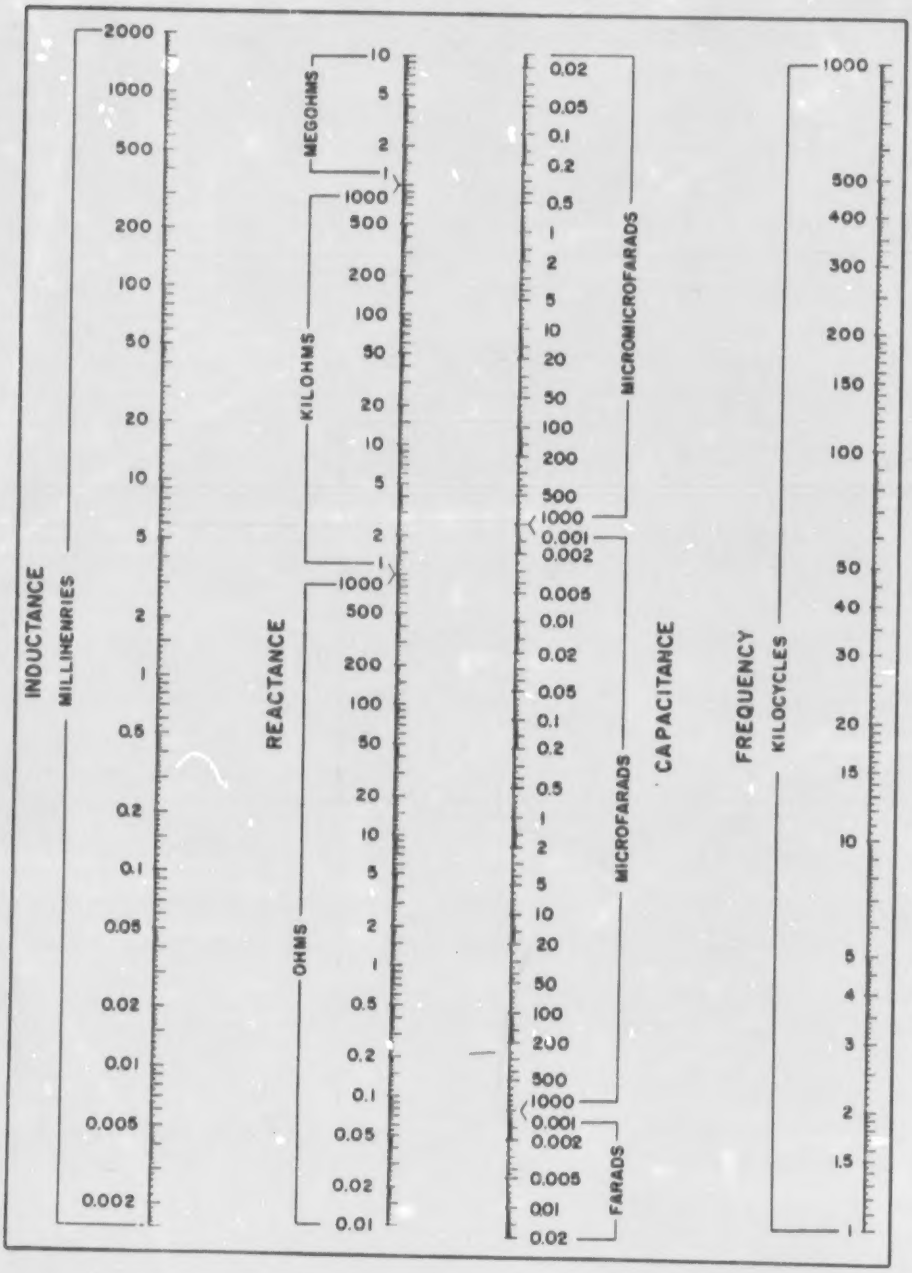
Chart for Solving Ohm's Equations

R. C. HITCHCOCK



Values given in Italics for volts, watts and ohms can be used with the one ampere scale to include a range of lower capacities

FREQUENCY-REACTANCE-CAPACITANCE-INDUCTANCE CHART (Cont)



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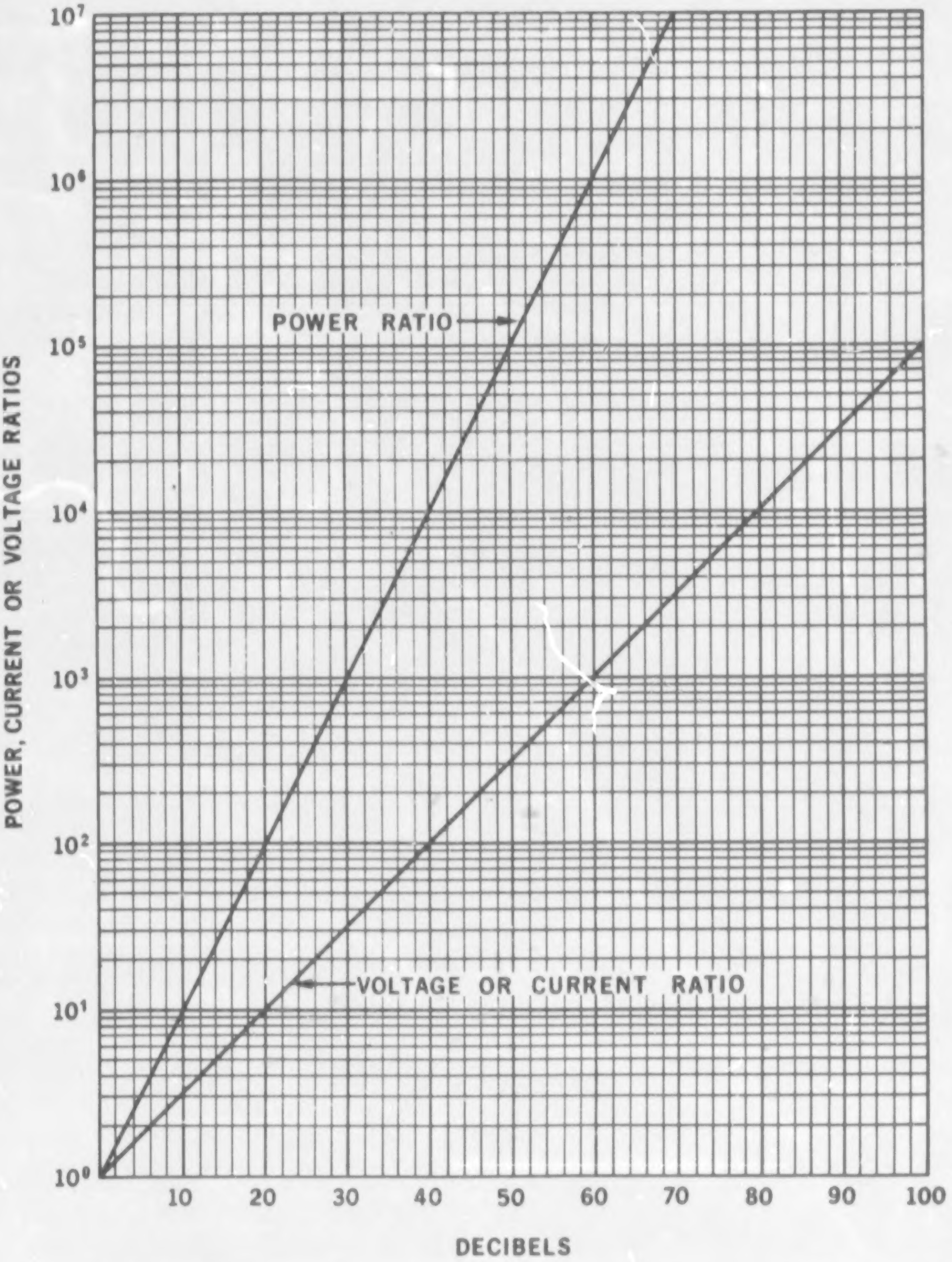

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SAMPLE WORK ORDER FORMS

Provided by Larry Mielcarz
Kankakee Area Career Center
Kankakee, Illinois 60901

OCCUPATIONAL SAFETY AND HEALTH ACT NOTES

Area or Equipment Inspected ______________________________

Inspected by ______________________ Date ______________

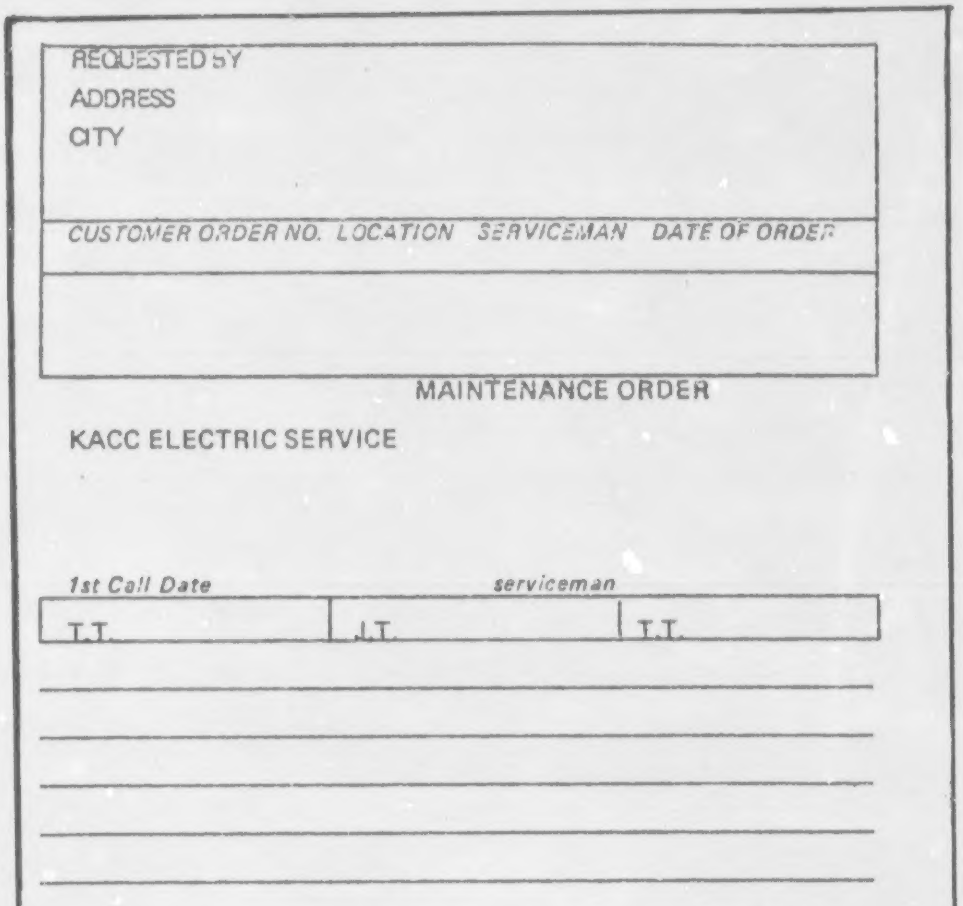
INSPECTION COMMENTS:

RE-INSPECTION REPORT

Area or Equipment Inspected ______________________________

Inspected by ______________________ Date ______________

INSPECTION COMMENTS:



REQUESTED BY
ADDRESS
CITY

CUSTOMER ORDER NO.	*LOCATION*	*SERVICEMAN*	*DATE OF ORDER*

MAINTENANCE ORDER

KACC ELECTRIC SERVICE

1st Call Date *serviceman*

T.T.	J.T.	T.T.

2nd Call Date *serviceman*

T.T.	J.T.	T.T.

Date

Signature

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material Total

DAILY TIME TICKET

STUDENT:

TIME SLOT:

DATE:

Starting Time	Finishing Time	Job Description

(Sample Work Order Forms--5)

ITEM				
DATE	STUDENT	IN	OUT	BALANCE

(Sample Work Order Forms--6)

ELECTRICAL CONSTRUCTION AND MAINTENANCE

SURVEY SHEET

LOCATION STUDENT DATE

REQUESTED BY

QUANITY	ITEM	SIZE	ESTIMATED PRICE
	ESTIMATED TOTAL		

WHAT YOU NEED TO KNOW TO TROUBLESHOOT!

Developed by Ernest Hopkins, Electronics Instructor
Parkland College, Champaign, Illinois

When an individual is beginning to learn how to troubleshoot, he may tend to go off in many different directions at once and become frustrated at not being able to solve electronic servicing problems except by a hit or miss process. To avoid this random guessing approach, the beginner needs guidance and direction in what he should know to troubleshoot effectively and efficiently. He needs to know how to proceed with his investigation once he has started. Many beginners look at a complicated piece of electronic equipment that contains 20 tubes or transistors, 200 or more capacitors and resistors, numerous transformers and diodes, and are awed and confused as what to do next. At this point many individuals are turned off by electronics because they feel they will never be able to work on anything that is so complicated. This author knows the feeling!

"You must crawl before you can walk" is an apt cliche at this point. By this it is meant that the individual should not tackle a complicated electronic system until he has mastered the circuits and he should not troubleshoot the circuits until he has a thorough knowledge of the components involved. He must also understand the relationship of the components to each other in the circuit and the relationships of the circuits to each other in the system.

There are some (including the author) that might say "This is all fine and good but I want to know where I'm supposed to go and how do I know when I get there in learning to troubleshoot?" The following is a general guide to troubleshooting that will aid the beginner in answering these questions and hopefully help to keep him on the right track when he starts to stray or become frustrated. This is meant to be an overview of troubleshooting in general and a guide to "how to proceed" with a complex system once the material in this text has been mastered. In learning how to troubleshoot from the beginning, the material in the following chapters will be covered in an inverted order to this list. That is, the components will be covered first then the circuits that are made up of these components and then systems that are made up of these circuits.

A GENERAL GUIDE TO TROUBLESHOOTING: QUESTIONS AND EXPLANATION

The following is a general and practical guide to troubleshooting most problems that will occur in an electronic system. It may appear as though much of this information is common sense, but "common sense" is not very common anymore. The steps are arranged in what can be considered a logical sequence. The questions asked, are the questions that should be asked at that step in the troubleshooting so as to proceed in an orderly fashion and avoid chaos. The suggestions made are based on the premise that the problem or problems need to be solved by the simplest and most expedient method.

A General Guide to Troubleshooting: Questions

Step I. Learn the function of the system!

1. What does the system do?
2. How does the system perform its function?
3. How are the circuits of the system interrelated to perform the overall function of the system?

Step II. Identify the symptom!

1. What does the system not do that it should?
2. What does the system do that it should do?
3. Are there any symptoms that can be detected by the senses? (smell, touch, sight, hearing)
4. Have you seen the symptom before?

Step III. Isolate the problem area!

1. What areas can cause the symptom?
2. What areas do not affect the symptom?
3. Can a quick visual inspection detect the problem area?
4. What measurement or test will aid in locating the problem area?
5. What test equipment will be required?
6. Have you had this problem before?

Step IV. Stop and think!

1. Is everything very confusing at this point?
2. Should you clear your mind of any preconceived ideas?
3. Should you start over?
4. Are you jumping around from one area to another without following a logical pattern or a logical sequence of events?

Step V. Isolate the problem to a specific area!

1. What is the function of the area?
2. How does it perform its function?
3. Will a close visual inspection detect the problem?
4. What measurement or test will aid in locating the problem the quickest?
5. What test equipment will be required?
6. What is the function of each component in the area?
7. What can be bad about each component?
8. How can the component be checked?
9. What caused the component to become defective?
10. If an exact replacement component is not available is there a suitable substitute?
11. Does replacing or repairing the defect solve the problem?
12. Will the unit continue to operate to acceptable standards?

(Following is a more detailed version of the outline)

Step I. Learn the functions of the system!

1. What does the system do?
    - A. A radio receiver converts electromagnetic energy at high frequencies into audio frequencies that can be detected by the ear.
    - B. The television receiver converts electromagnetic energy at high frequencies into audio frequencies to which the ear can respond and to light impulses to which the eye can respond.
    - C. The tape recorder converts intelligence that has been stored on magnetic tape into audio energy to which our ears can respond and the system must move the tape mechanically so as provide continuous intelligence.
2. How does the system perform its function?
    - A. Amplifiers are used to increase the amplitude of signals.
    - B. Oscillators must be used to generate a constant signal within the system.
    - C. Mixers are sometimes used to combine signals.

D. Detectors are used to separate signals.

E. Waveshaping circuits are used to change or modify existing waveforms into a more useable form.

F. Transducers are used to convert one form of energy into another form. Voltage to accoustical energy.

G. Motors are used to cause mechanical movement.

H. Adjustments and controls are placed within the system to allow for tolerance interface between components and for component aging.

3. How are the circuits for the system interrelated to perform the overall function of the system?

A. Some stages depend on an input from a previous state and then send the output on to following stages. In other cases the output from a stage is sent back to previous stages for purposes of controlling the previous stages.

Step II. Identify the symptom!

1. What does the system not do that it should?

A. The system is completely dead and no performance can be detected.

B. The system is producing a noise but no intelligence.

C. The system has no or improper mechanical movement.

D. The system produces aural intelligence but no visual intelligence.

E. The system produces a visual but no aural intelligence.

F. The system produces all functions required but not to an acceptable standard.

G. The system produces functions that are at an acceptable standard but intermittently.

2. What does the system do that it should?

A. Many times by noting what the system does do, the stages that perform these functions correctly can be ignored. This is important because the more complex the system the more you can ignore when those stages are performing correctly.

3. Are there any symptoms that can be detected by the senses? (sight, hearing, smell, touch)

A. Perform a visual inspection of the system to locate any broken wires, burned or broken parts, signs of smoke, broken or cracked printed circuit boards, loose connections and hardware, and burned out vacuum tubes.

B. Listen for any strange noise such as arcing, howling, frying, and chattering.

C. Use the nose to detect any strange odors that indicate over-heated components such as resistors and transformers.

D. Touch the cases of transistors, transformers, electrolitic capacitors, and resistors for any unusually high temperatures. (Be careful of large transformers, resistors and some power transistors; these do have rather warm cases.)

4. Have you seen the symptom before?

A. Learn to categorize and relate various combinations of symptoms. This will aid in the future troubleshooting of similar systems and in turn reduce the time required for identifying all the symptoms and will enable you to better relate the symptoms to the problem.

Step III. Isolate the problem to a general area!

1. What areas can cause the symptom?

A. If the system is completely dead and a visual inspection indicates that the filament are not lit, then the only area that can cause this situation is the low voltage power supply.

B. If the turntable of a phonograph is not rotating, then this problem can be associated with either the power supply or the mechanical section of the system. This problem will not normally be associated with a defective amplifier unless of course the amplifier is overloading the power supply and causing it to become inoperative.

C. If the signal that is processed through the system is weak, then this would be an indication that there is lack of amplification and therefore checking the amplifiers would be a logical step to perform.

2. What areas do not affect the symptom?

A. If a television receiver has a good picture but poor or no sound signal, then only those stages that contain the sound signal need be checked and the stages that do not incorporate the sound signal can be ignored. Therefore in the more complicated systems, it is easier to locate the problem area by noting which of the areas of the system are functioning normally.

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3. Can a quick visual inspection detect the problem area?

   A. In this case, the whole system is being visually checked and in the more complex systems, such as a color television, anything but a quick inspection (2 to 5 minutes) would involve a loss of time in troubleshooting. For example, an open capacitor or transistor cannot be spotted visually, but a broken wire, or burned out filament or a blown fuse is quick and easy to detect.

4. What measurement or test will aid in locating the problem area?

   A. The test or measurement to be made will depend somewhat on the system, the symptom, and test equipment available. In one case the signal injection method might be best, while in another case, signal tracing might be best suited for isolating the problem.

5. What test equipment will be required?

   A. It must be decided on the basis of what the symptom is and what equipment is available. The frequency and amplitude of a piece of test equipment must be taken into consideration for some applications. Some systems such as television may require special types of signals to apply to it in order to aid in troubleshooting. For some troubleshooting problems, it is best to have a visual output indicator rather than an aural indication. This would be especially true where waveforms are of prime importance as related to function performed.

6. Have you had this problem before?

   A. Many times previous experience with problems can help in guiding the troubleshooter to a likely trouble area because he has had the same type of problem before, especially if it is the same model or chassis that he has worked on before. Some particular models seem to have a weakness in one particular part of the system due to its design.

Step IV. Stop and think!

1. Is everything very confusing at this point?

   A. There are times in every technician's life when he tends to run around in circles and a solution to the problem evades him. This can be caused by having missed anyone of the steps above or having avoided a logical sequence of events up to this point. Sometimes a review of data collected, symptoms present, or measurements made will allow the technician to progress.

2. Should you clear your mind of preconceived ideas?

    A. Sometimes previous experience has taught us that a particular symptom is caused by a certain defect; but when that area is checked, it is found to be in good order. Once this has been determined leave that area alone. Too many times the technician is so convinced that the problem is in this area that he wastes time by continually returning to this area because he has a preconceived idea about the solution.

3. Should you start over?

    A. Interruptions and taking up troubleshooting where someone else left off or using data someone else has collected can lead a technician down the wrong path of analysis. In this case, it is best to start over.

4. Are you jumping around from one area to another without following a logical pattern or a logical sequence of events?

    A. This can be caused by either of items 1 and 2 above in this step or just one of those nervous and jumpy days that we all get.

Step V. Isolate the problem to a specific area!

1. What is the function of the specific area?

    A. Is it an amplifier, an oscillator, a power supply, or a signal splitter. Knowing the function will help in deciding what is not being performed properly.

2. How does it perform its function?

    A. Knowing how the area goes about performing its function will help to isolate which of the components in the area could cause such a problem. It will also alert the technician as to what to look for when making measurements and collecting data.

3. Will a close visual inspection detect the problem?

    A. At this point in isolating the problem, the technician only has a few components and a small area for concern. It may be a good idea to take a few minutes and closely inspect such items as cracked boards and components that might have been missed by the quick inspection.

4. What test equipment will be required?

    A. The test equipment required at this level may be different than it was when the problem was being isolated down to a general area. Here voltage measurements may be of great importance because this is what is reflected in the tech data.

Sometimes current measurements are given in the data; but to make such measurements, the circuit path must be broken and this is not always convenient to do. Therefore, a voltage measurement across a known resistance will yield the same information by simple computation.

5. What test equipment will be required?

   A. The loading effect of the test equipment may dictate which equipment is to be used. As to whether measurements can be made with power on or off may be another important factor.

6. What is the function of each component in the area?

   A. By knowing the component's function, it can be determined as to whether that particular component's being bad can cause the problem in that area.

7. What can be bad about each component?

   A. Shorted, open, leaky, increased or decreased value are various symptoms that a component can exhibit. Knowing the defect that a component can have, can alert the technician to what to look for in checking out that component.

8. How can the component be checked?

   A. A diode and sometimes a coil or transformer can be simply checked with an ohmmeter but it must usually be disconnected from the rest of the circuit. A capacitor can be checked sometimes with an ohmmeter (if it is 1 ufd or larger) but at other times it is best to use a capacitance checker if one is available. There is always the direct replacement method which is usually the best method if you don't wipe out the replacement in the process.

9. What caused the component to become defective?

   A. Many times a bad transistor may be found in a circuit and it is replaced with a new one, but a short time later it too becomes defective. This gets to be expensive. Therefore, when a component becomes defective, it may have done it on its own or another component's having become defective took the transistor or components with it. It is a good idea, in this case, to check the other components associated with the defective one.

10. If an exact replacement component is not available, is there a suitable substitute?

    A. The use of part substitution manuals can reduce the down time on defective equipment. (It would be terrible to have to send to Hong Kong or Tokyo for a transistor!) There are special cases where suitable substitutes will not work very well. Tubes are an example of this problem. Current requirements of the filament may be different and this would be fine in a parallel filament arrangement but not so good for a series strung set.

11. Does replacing or repairing the defect solve the problem?

    A. It could be that your analysis of the suspected part was wrong and it really wasn't bad and the problem still exists. There might be more than one problem.

12. Will the unit continue to operate to acceptable standards?

    A. Some repairs will correct the defect but the quality has decreased. This might be due to the interface of the new component to the older ones in the systems and alignment is called for. The poor quality could be caused by a suitable substitute being used that is not so suitable.

    B. Continued performance of the repaired unit is often neglected; because once a defective component is replaced, it is assumed that the problem is solved. Reviewing item 9 above, we find that maybe something caused the component replaced to become defective and until that something is corrected the unit cannot be considered to be totally repaired. The repaired unit should be operated under normal conditions for a period of time after the repair has been made.

The preceding outline and guide to troubleshooting is only meant to let the beginning troubleshooter know what he is in for when servicing electronic systems and circuits. As each of the succeeding chapters is covered, the individual should return to this outline/guide and review the appropriate area to see how the material covered fits into the overall logic of troubleshooting.

LIST OF EQUIPMENT FOR
ELECTRIC MOTOR PROTECTION AND CONTROL PANEL

Courtesy of
Department of Agricultural Education
The Pennsylvania State University
University Park, PA 16802

Quantity	Description
2	Standard-mount pillow blocks, 5/8" diameter bore
3	Three-piece flexible couplings, 5/8" diameter bore (2 bodies and 1 spider per coupling)
3	Extra spiders @ $.30 each
1	Shaft, 5/8" diameter x 12" long
1	Flat pulley, 2" wide x 6" diameter x 5/8" diameter bore
1	Split phase motor, 1/2 hp, 115 volt, 5/8" diameter shaft
1	Capacitor start motor, 1/2 hp, 115/230 volt, 5/8" diameter shaft
1	Repulsion start-induction run motor, 1/2 hp, 115/230 volt, 5/8" diameter shaft
1 sheet	Plywood, 3/4" Type A-C interior (panel 48" x 36", base 36" x 24")
	Magnetic starter (Cutler-Hammer, #A10CGOA)
1	Push button station (Cutler-Hammer, #H5200)
1	Limit switch and lever (Cutler-Hammer, #10316H187 and #202)
1	Manual starter (Cutler-Hammer, #9115H169)
1	Toggle switch manual starter or fractional horsepower motor starter (Cutler-Hammer. #9101H74)
1	Plug-fuse switch or 2-pole, 30 amps disconnect (Cutler-Hammer, #414H341)
	AC Voltmeter, 4-1/2 wide-vue,)-150 range, Simpson #1359)
	AC Ammeter, 4-1/2 wide-vue, 0-50 range, Simpson #1359)
	Amprobe Jr. Test Master Kit, Model #TM-YO "525"
	Miscellaneous supplies (Local supplier): 10 - feet of 1/2" thin wall conduit 20 - conduit to box connectors 1 - tee for conduit 2 - 90° elbows 15 - feet each of black and white single conductor, TW, AWG #14 solid 10 - feet each of black, red, and yellow single conductor, TW, AWG #18 stranded 10 - feet of 3-wire SJ power cord, AWG #16 6 - 2" x 4" surface mount utility boxes 3 - parallel ground duplex receptacles and cover plates 1 - three way 15 amp, toggle switch with cover plate 1 - fused, parallel grounded receptacle 50 - feet of 2-AWG #14, NM or NMC 50 - feet of 2-AWG #18, lamp cord 1 - parallel grounded cap (115v, 15 amp)

ELECTRIC MOTORS COURSE STRUCTURE

Courtesy of
Department of Agricultural Education
The Pennsylvania State University
University Park, PA 16802

Operational Level

Questions to be answered and areas to teach.

1. Jobs available
2. Safety (fusing & reset)
3. Where are motors used in industry
4. Advantages - (efficiency of operation)
5. What are the different types of motors and types of motor cases
6. Understanding the nameplate
7. Parts identification (nomenclature)
8. Connection of motor to load (drives)
9. Replacing a motor
10. Conservation of energy

Task Sheets

1. Clean and lubricate
2. Color Code (wire)
3. Tools used for electric motors - (kinds & names)
4. Name plate
5. Troubleshooting
6. Handling electrical appliances
7. Motor Enclosures
8. Cheater-water on-fire extinguisher insulated cases - grounding - care of cords and cables - cord size - equipment shields - clothing - eye protection - cleaning fluids
9. Proper bonding-cheater
10. Adequate motor control - switches, plugs and clamps, underwriters knot
11. Soldering and attaching wires
12. Circuit protectors
13. Motor protectors
14. Controls - thermostate & humidistate
15. Understanding low voltage switching
16. Belt alignment (drives)
17. Attach pulley to shift - (set screw, keys, etc.)
18. Speed and size of pulley
19. V-belts

Skilled Level

Questions to be answered and areas to teach.

1. Selection of motor
2. How induction motors start and run
3. Advantages of 120 over 240
4. Troubleshooting
5. Understand why a motor fails
6. Wire size to use
7. How do you disassemble a motor?
8. Which electrical terms are important?

Task Sheets

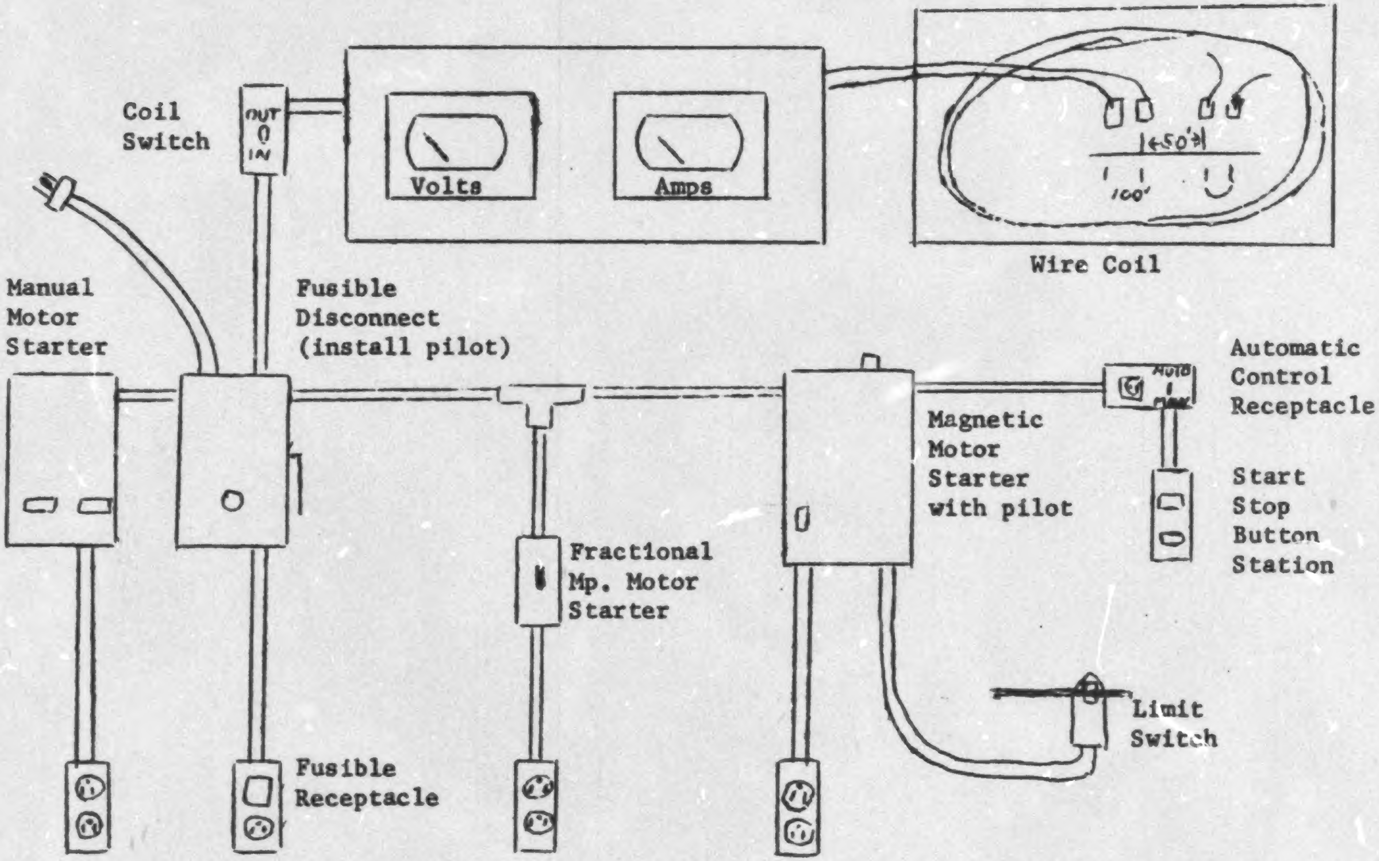
1. Electrical terms - volt, amp, watt, KWH, kilowatt, KVA, circuit, conductors, circuit breakers
2. Disassembly-assembly procedures
3. Replacing bushings and bearings
4. Replace brushes
5. Read micrometer
6. Measure and adjust end play
7. Read and analyze with meter
8. Read schematics and blueprints
9. Wire for change of direction
10. Wire for change of voltage
11. Replace reset button
12. Replace starting switch
13. Replace capacitor
14. Reface armature and cut wire
15. Test grounded circuit
16. Hook up relay for low voltage switching

Technical Level

1. Wind or rewind motors
2. Design systems

The Pennsylvania State University
Department of Agricultural Education
102 Armsby
University Park, PA 16802

ELECTRIC MOTOR
DEMONSTRATION BOARD


Coil Switch
OUT
0
IN
Volts
Amps
←50'→
100'
Wire Coil
Manual Motor Starter
Fusible Disconnect (install pilot)
Automatic Control Receptacle
AUTO
MAN
Magnetic Motor Starter with pilot
Start Stop Button Station
Fractional Mp. Motor Starter
Limit Switch
Fusible Receptacle

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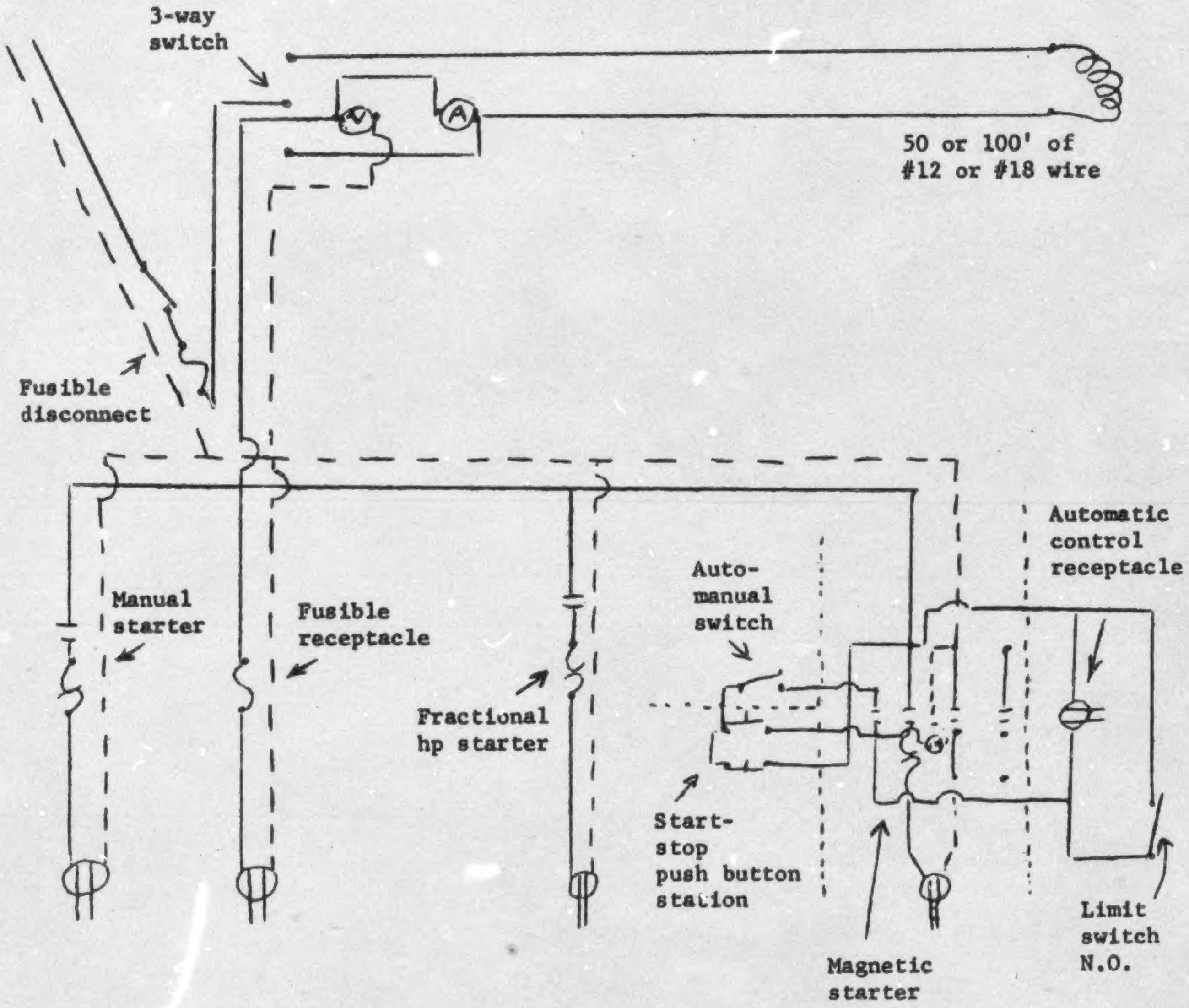
ELECTRIC MOTOR DEMONSTRATION BOARD LAYOUT


3-way switch
50 or 100' of #12 or #18 wire
Fusible disconnect
Automatic control receptacle
Auto-manual switch
Manual starter
Fusible receptacle
Fractional hp starter
Start-stop push button station
Magnetic starter
Limit switch N.O.

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Glossary

ABRASIVE: A material that cuts material that is softer than itself, such as emery, aluminum oxide and diamonds. It may be used in loose form, mounted on cloth, paper or bonded on a wheel.

ABSOLUTE SYSTEM: A system of numerically controlled machining that measures all coordinates from a fixed point of origin or zero point. Also known as point-to-point N/C machining.

ACCUMULATOR: A container in which fluid is stored under pressure as a source of fluid power.

ACTUATOR: A device for converting hydraulic energy into mechanical energy. A motor or cylinder.

ADDENDUM: The radial distance between the pitch circle and the top of the tooth.

ALCLAD: An aluminum alloy core with a thin coating of pure aluminum to prevent corrosion of the core metal.

ALLOWANCE: The intentional difference in the dimensions of mating parts to provide for different classes of fits.

ALLOY: A mixture of two or more metals fused or melted together to form a new metal.

ANNEAL: To soften metals by heating to remove internal stresses caused by rolling and forging.

ANODIZE: The process of protecting aluminum by oxidizing in an acid bath using a d-c current.

ARBOR: A shaft or spindle for holding cutting tools.

ASSEMBLY DRAWING: A drawing showing the working relationship of the various parts of a machine or structure as they fit together.

BACKLASH: The play (lost motion) between moving parts, such as threaded shaft and nut or the teeth of meshing gears.

BASIC DIMENSION: A theoretically exact value used to describe the size, shape or location of a feature.

BASIC SIZE: That size from which the limits of size are derived by the application of allowances and tolerances.

BEND ALLOWANCE: The amount of sheet metal required to make a bend over a specific radius.

BLANCHARDIZE: An operation which removes large amounts of stock through rotary grinding. Normally, it is a first operation for preparing castings for finish operations.

BLANKING: A stamping operation in which a press uses a die to cut blanks from flat sheets or strips of metal.

BORING: Enlarging a hole to a specified dimension by use of a boring bar. May be done on a lathe, jig bore, boring machine or mill.

BOSS: A small local thickening of the body of a casting or forging to allow more thickness for a bearing area or to support threads.

BRAZE: To join two close fitting metal parts with heat and a filler material of zinc and copper alloy.

BROACH: A tool for removing metal by pulling or pushing it across the work. The most common use is producing irregular hole shapes such as squares, hexagons, ovals or splines.

BURNISH: To smooth or polish metal by rolling or sliding tool over surface under pressure.

BURR: The ragged edge or ridge left on metal after a cutting operation.

BUSHING: A metal lining which acts as a bearing between rotating parts such as a shaft and pulley. Also used on jigs to guide cutting tool.

CALLOUT: A note on the blueprint giving a dimension, specification or a machine process.

CAM: A rotating or sliding device used to convert rotary motion into intermittent or reciprocating motion.

CARBURIZE: The heating of low-carbon steel for a period of time to a temperature below its melting point in carbonaceous solids, liquids or gases, then cooling slowly in preparation for heat treating.

CASE HARDENING: The process of hardening ferrous alloy so that the surface layer or case is made much harder than the interior core.

CASTING: An object made by pouring molten metal in a mold.

CHECK VALVE: A valve which permits flow of fluid in one direction only.

CHOKE: A restriction, the length of which is large with respect to its cross-sectional dimension.

CIRCUIT: The complete path of flow in a hydraulic system including the flow-generating device.

CIRCUIT DIAGRAM: A line drawing using graphic symbols or pictorial views to show the complete path of flow in a hydraulic system.

CIRCULAR PITCH: The length of the arc along the pitch circle between the center of one gear tooth to the center of the next.

CLOSED LOOP: A system in which the output of one or more elements is compared to some other signal to provide an actuating signal to control the output of the loop.

COMMAND SIGNAL (or input signal): An external signal to which the servo must respond.

COMPONENT: A single unit or part.

CONCENTRIC: Having a common center as circles or diameters.

CONTOUR: The outline of an object.

CONTROL: A device used to regulate the function of a unit.

COOLER: A heat exchanger used to remove heat from the hydraulic fluid.

COUNTERBORE: The enlargement of the end of a hole to a specified diameter and depth.

COUNTERSINK: The chamfered end of a hole to receive a flat head screw.

DASH NUMBER: A number preceded by a dash after the drawing number that indicates right- or left-hand parts as well as neutral parts and/or detail and assembly drawings. The coding is usually special to a particular industry.

DATUM: A point, line, surface or plane assumed to be exact for purposes of computation from which the location of other features are established.

DEDENDUM: The radial distance between the pitch circle and the bottom of the tooth.

DESIGN SIZE: The size of a feature after an allowance for clearance has been applied and tolerances have been assigned.

DETAIL DRAWING: A drawing of a single part that provides all the information necessary in the production of that part.

DIE: A tool used to cut external threads by hand or machine. Also a tool used to impart a desired shape to a piece of metal.

DIE-CASTING: A method of casting metal under pressure by injecting into metal dies of a die-casting machine. Also the part formed by die-casting.

DIE STAMPING: A piece cut out by a die.

DISPLACEMENT: The quantity of fluid which can pass through a pump, motor or cylinder in a single revolution or stroke.

DOWEL PIN: A pin which fits into a hole in an abutting piece to prevent motion or slipping, or to ensure accurate location of assembly.

DRAFT: The angle or taper on a pattern or casting that permits easy removal from the mold or forming die.

ECCENTRIC: Not having a common center. A device that converts rotary motion into reciprocating (back and forth) motion.

EFFECTIVITY: The serial number(s) of an aircraft, machine, assembly or part on which a drawing change applies. The change may be indicated as an effective date and would apply on that date forward.

ENCLOSURE: A rectangle drawn around a component or components to indicate the limits of an assembly. Port connections are shown on the enclosure line.

EXTRUSION: Metal which has been shaped by forcing it in the hot or cold state through dies of the desired shape.

FEATURE: A portion of a part, such as a diameter, hole, keyway or flat surface.

FEEDBACK (or feedback signal): The output signal from a feedback element.

FERROUS: Metals that have iron as their base material.

FILLET: A concave intersection between two surfaces to strengthen the area.

FILTER: A device whose primary function is the retention by a porous media of insoluble contaminants from a fluid.

FINISH: General finish requirements such as paint, chemical or electroplating rather than surface texture or roughness. (See surface texture.)

FIT: The clearance or interference between two mating parts.

FIXTURE: A device used to position and hold a part in a machine tool. It does not guide the cutting tool.

FLANGE: An edge or collar fixed at an angle to the main part or web as an I-beam.

FLAT PATTERN: A layout showing true dimensions of a part before bending. May be actual size pattern on polyester film for shop use.

FLUID:

1. A liquid or gas.
2. A liquid that is specially compounded for use as a power-transmitting medium in a hydraulic system.

FLUIDICS: A contraction of the words "fluid" and "logic," fluidics is a technology concerned with logical control functions and makes use of low pressure fluid interaction to produce control signals. Fluidic devices have no moving parts.

FORGING: Metal shaped under pressure with or without heat.

FORM TOLERANCING: Permitted variation of a feature from the perfect form indicated on the drawing.

FUSION WELD: The intimate mixing of molten metals.

GEOMETRIC DIMENSIONING AND TOLERANCING: A means of dimensioning and tolerancing a drawing with respect to the actual function or relationship of part features which can be most economically produced. It includes positional and form dimensioning and tolerancing.

GUSSET: A small plate used in reinforcing assemblies.

HARDNESS TEST: Techniques used to measure the degree of hardness of heat-treated materials.

HEAT EXCHANGER: A device which transfers heat through a conducting wall from one fluid to another.

HEAT TREATMENT: The application of

heat to metals to produce desired qualities of hardness, toughness and/or softness. (See anneal.)

HOBBING: A special gear cutting process. The gear blank and hob rotate together as in mesh during the cutting operation.

HONE: A method of finishing a hole or other surface to a precise tolerance by using a spring loaded abrasive block and rotary motion.

HORSEPOWER (HP): The power required to lift 550 pounds one foot in one second or 33,000 pounds one foot in one minute. A horsepower is equal to 746 watts or to 42.4 British thermal units per minute.

HYDRAULIC CONTROL: Control which is actuated by hydraulically induced forces.

HYDRAULICS: Engineering science pertaining to liquid pressure and flow.

INCREMENTAL SYSTEM: A system of numerically controlled machining that always refers to the preceding point when making the next movement. Also known as continuous path or contouring method of N/C machining.

INDICATOR: A precision measuring instrument for checking the trueness of work.

INTERCHANGEABILITY: The condition that assures the universal exchange or mutual substitution of units or parts of a mechanism or an assembly.

INVOLUTE: A spiral curve generated by a point on a chord as it unwinds from a circle or a polygon.

JIG: A device used to hold a part to be machined and positions and guides the cutting tool.

JOGGLE: A bend in a part to fit over other parts.

KERF: The slit or channel left by a saw or other cutting tool.

KEY: A small piece of metal (usually a pin or bar) used to prevent rotation of a gear or pulley on a shaft.

KNURL: The process of marking the surface of a part by rolling depressions in the surface.

LAP: To finish a surface with a very fine abrasive impregnated in a soft metal.

LIMITS: The extreme permissible dimensions of a part resulting from the application of a tolerance.

MAGNAFLUX: A nondestructive inspection technique that makes use of a magnetic field and magnetic particles to locate internal flaws in ferrous metal parts.

MAXIMUM MATERIAL CONDITION: When a feature contains the maximum amount of material, that is: minimum hole diameter and maximum shaft diameter. Abbreviated MMC.

MILL: To remove metal with a rotating cutting tool on a milling machine.

MISMATCH: The variance between depths of machine cuts on a given surface.

NEXT ASSEMBLY: The next object or machine on which the part or sub-assembly is to be used.

NOMINAL SIZE: A general classification term used to designate size of a commercial product.

NONFERROUS: Metals not derived from an iron base or an iron alloy base, such as aluminum, magnesium and copper.

NORMALIZING: A process in which ferrous alloys are heated and then cooled in still air to room temperatures to restore the uniform grain structure free of strains caused by cold working or welding.

ORTHOGRAPHIC PROJECTION: A multiview drawing that shows every feature of an object in its true size and shape.

PASSIVATION: Particularly applicable to stainless steel, it is a conditioning of the surface with a low strength nitric acid dip that develops the "stainless" property and prevents random staining due to "free iron" particles left from machining.

PICKLE: The removal of stains and oxide scales from parts by immersion in an acid solution.

PILOT: A protruding diameter on the end

of a cutting tool designed to fit in a hole and guide the cutter in machining the area around the hole.

PILOT HOLE: A small hole used to guide a cutting tool for making a larger hole. Also used to guide drill of larger size.

PILOT VALVE: An auxiliary valve used to control the operation of another valve. The controlling stage of a 2-stage valve.

PINION: The smaller of two mating gears.

PITCH: The distance from a point on one thread to a corresponding point on the next thread.

PLAN VIEW: The top view of an object.

PORT: An internal or external terminus of a passage in a component.

POSITIONAL TOLERANCING: The permitted variation of a feature from the exact or true position indicated on the drawing.

PROCESS SPECIFICATION: A description of the exact procedures, materials and equipment to be used in performing a particular operation such as a milling operation or spray painting.

PUMP: A device which converts mechanical force and motion into hydraulic fluid power.

QUENCHING: Cooling metals rapidly by immersing them in liquids or gases.

RAM: A single-acting cylinder with a single diameter plunger rather than a piston and rod. The plunger in a ram-type cylinder.

REAMING: To finish a drilled hole to a close tolerance.

RECIPROCATION: A straight line, back-and-forth motion or oscillation.

REFERENCE DIMENSION: Used only for information purposes and does not govern production or inspection operations.

REGARDLESS OF FEATURE SIZE (RFS): The condition where tolerance of position or form must be met irrespective of where the feature lies within its size tolerance.

RELEASE NOTICE: The authorization indicating the drawing has been cleared for use in production.

RELIEF VALVE: Pressure operated valve which bypasses pump delivery to the reservoir, limiting system pressure to a predetermined maximum value.

RESERVOIR: A container for storage of liquid in a fluid power system.

RESISTANCE WELDING: The process of welding metals by using the resistance of the metals to the flow of electricity to produce the heat for fusion of the metals.

RESTRICTION: A reduced cross-sectional area in a line or passage which produces a pressure drop.

ROTARY ACTUATOR: A device for converting hydraulic energy into rotary motion - - a hydraulic motor.

SANDBLAST: The process of removing surface scale from metal by blowing a grit material against it at very high air pressure.

SECTION: A cross-sectional view at a specified point of a part or assembly.

SENSOR: Devices which convert physical conditions into information which can be understood by the control system.

SEQUENCE:

1. The order of a series of operations or movements.
2. To divert flow to accomplish a subsequent operation or movement.

SERRATIONS: Condition of a surface or edge having notches or sharp teeth.

SERVO MECHANISM: A mechanism subjected to the action of a controlling device which will operate as if it were directly actuated by the controlling device, but capable of supplying power output many times that of the controlling device, this power being derived from an external and independent source.

SHIM: A piece of thin metal used between mating parts to adjust their fit.

SOLENOID: A coil of wire carrying an electric current possessing the characteristics of a magnet.

SPECIFICATION: A detailed description of a part or material giving all information not shown on the graphic part of the blueprint such as quality, size, quantity and manufacturer's name.

SPLINE: A raised area on a shaft (external) designed to fit into a recessed area of a mating part.

SPOT FACE: A machined circular spot on the surface of a part to provide a flat bearing surface for a screw, bolt, nut, washer or rivet head.

SPOT WELD: A resistance type weld that joins pieces of metal by welding separate spots rather than a continuous weld.

STRESS RELIEVING: To heat a metal part to a suitable temperature and hold that temperature for a determined time then cooled gradually in air. This treatment reduces the internal stresses induced by casting, quenching, machining, cold working or welding.

SUMP: A reservoir.

SUPERSEDENCE: The replacing of one part by another. A part that has been replaced is said to be superseded.

SURFACE TEXTURE: The lay, roughness, waviness and flaws of a surface.

TABULAR DIMENSION: A type of rectangular datum dimensioning in which dimensions from mutually perpendicular datum planes are listed in a table on the drawing instead of on pictorial portion.

TANGENT: A line drawn to the surface of an arc or circle so that it contacts the arc or circle at only one point.

TAP: A rotating tool used to produce internal threads by hand or machine.

TEMPERING: Creating ductility and toughness in metal by heat treatment process.

TEMPLATE: A pattern or guide.

TENSILE STRENGTH: The maximum load (pull) a piece can support without breakage or failure.

TOLERANCE: The total amount of variation permitted from the design size of a part.

TORQUE: The rotational or twisting force in a turning shaft.

TRANSDUCER (or feedback transducer): An element which measures the results at the load and sends a signal back to the amplifier.

TRUE POSITION: The basic or theoretically exact position of a feature.

TUMBLING: The process of removing rough edges from parts by placing them in a rotating drum that contains abrasive stones, liquid and a detergent.

TYPICAL (TYP): This term, when associated with any dimension or feature, means the dimension or feature applies to the locations that appear to be identical in size and configuration.

VERNIER SCALE: A small moveable scale attached to a larger fixed scale, for obtaining fractional subdivisions of the fixed scale.

WORKING DRAWING: A set of drawings which provide details for the production of each part and information for the correct assembly of the finished product.

Standard Abbreviations

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Detail	DET
Developed Length	DL
Developed Width	DW
Deviation	DEV
Diagonal	DIAG
Diagram	DIAG
Diameter	DIA
Diameter Bolt Circle	DBC
Diametral Pitch	DP
Dimension	DIM
Disconnect	DISC
Dowel	DWL
Draft	DFT
Drafting Room Manual	DRM
Drawing	DWG
Drawing Change Notice	DCN
Drill	DR
Drop Forge	DF
Duplicate	DUP
E	
Each	EA
Eccentric	ECC
Effective	EFF
Electric	ELEC
Enclosure	ENCL
Engine	ENG
Engineer	ENGR
Engineering	ENGRG
Engineering Change Order	ECO
Engineering Order	EO
Equal	EQ
Equivalent	EQUIV
Estimate	EST
F	
Fabricate	FAB
Fillet	FIL
Finish	FIN
Finish All Over	FAO
Fitting	FTG
Fixed	FXD
Fixture	FIX
Flange	FLG
Flat Head	FHD
Flat Pattern	F/P
Flexible	FLEX
Fluid	FL
Forged Steel	FST
Forging	FORG
Furnish	FURN
G	
Gage	GA
Gallon	GAL
Galvanized	GALV
Gasket	GSKT
Generator	GEN
Grind	GRD
Ground	GRD
H	
Half-Hard	1/2 H
Handle	HDL
Harden	HDN
Head	HD
Heat Treat	HT TR
Hexagon	HEX
High Carbon Steel	HCS
High Frequency	HF
High Speed	HS
Horizontal	HOR
Hot-Rolled Steel	HRS
Hour	HR
Housing	HSG
Hydraulic	HYD
Hydrostatic	HYDRO
I	
Identification	IDENT
Impregnate	IMPG
Inch	IN
Inclined	INCL
Include, Including, Inclusive	INCL
Increase	INCR
Independent	INDEP
Indicator	IND
Information	INFO
Inside Diameter	ID
Installation	INSTL
Interrupt	INTER
J	
Joggle	JOG
Junction	JCT
K	
Keyway	KWY
L	
Laboratory	LAB
Lacquer	LAQ
Laminate	LAM
Left Hand	LH
Length	LG
Letter	LTR
Limited	LTD
Limit Switch	LS
Linear	LIN
Liquid	LIQ
List of Material	L/M
Long	LG
Low Carbon	LC
Lubricate	LUB
M	
Magnaflux	M
Magnesium	MAG
Maintenance	MAINT
Major	MAJ
Malleable	MALL
Malleable Iron	MI
Manual	MAN
Mark	MK
Master Switch	MS
Material	MATL
Maximum	MAX

Measure	MEAS
Mechanical	MECH
Medium	MED
Middle	MID
Military	MIL
Minimum	MIN
Miscellaneous	MISC
Modification	MOD
Mold Line	ML
Motor	MOT
Multiple	MULT
N	
Nickel Steel	NS
Nomenclature	NOM
Nominal	NOM
Normalize	NORM
Not to Scale	NTS
Number	NO
O	
Obsolete	OBS
Opposite	OPP
Ounce	OZ
Outside Diameter	OD
Over-All	OA
P	
Package	PKG
Parting Line (Castings)	PL
Pattern	PATT
Piece	PC
Pilot	PLT
Pitch	P
Pitch Circle	PC
Pitch Diameter	PD
Plan View	PV
Plastic	PLSTC
Plate	PL
Pneumatic	PNEU
Port	P
Positive	POS
Pounds Per Square Inch	PSI
Pounds Per Square Inch Gage	PSIG
Pressure	PRESS
Primary	PRI
Process, Procedure	PROC
Product, Production	PROD
Q	
Quality	QUAL
Quantity	QTY
Quarter-Hard	1/4 H
R	
Radius	RAD or R
Ream	RM
Receptacle	RECP
Reference	REF
Regular	REG
Regulator	REG
Release	REL
Required	REQD
Right Hand	RH

Rivet	RIV
Rockwell Hardness	RH
Round	RD
S	
Schedule	SCH
Schematic	SCHEM
Screw	SCR
Screw Threads	
American National Coarse	NC
American National Fine	NF
American National Extra Fine	NEF
American National 8 Pitch	8N
American Standard Taper Pipe	NTP
American Standard Straight Pipe	NPSC
American Standard Taper (Dryseal)	NPTF
American Standard Straight (Dryseal)	NPSF
Unified Screw Thread Coarse	UNC
Unified Screw Thread Fine	UNF
Unified Screw Thread Extra Fine	UNEF
Unified Screw Thread 8 Thread	8UN
Section	SECT
Sequence	SEQ
Serial	SER
Serrate	SERR
Sheet	SH
Silver Solder	SILS
Solenoid	SOL
Special	SPL
Specification	SPEC
Spot Face	SF
Stainless Steel	SST
Steel	STL
Stock	STK
Symbol	SYM
Symmetrical	SYM
System	SYS
T	
Tabulate	TAB
Tangent	TAN
Tapping	TAP
Teeth	T
Tensil Strength	TS
Thick	THK
Thread	THD
Tolerance	TOL
Tool Steel	TS
Torque	TOR
Total Indicator Reading	TIR
True Involute Form	TIF
Tungsten	TU
Typical	TYP

Standard Abbreviations

V		W	
Vacuum	VAC	Washer	WASH
Variable	VAR	Watt	W
Vernier	VER	Weatherproof	WP
Vertical	VERT	Wide, Width	W
Vibrate	VIB	Wrought Iron	WI
Void	VD	Y	
Volt	V	Yield Point (PSI)	YP
Volume	VOL	Yield Strength (PSI)	YS

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Standard
Tables and Symbols

Decimal and Metric Equivalents

INCHES		MILLI-METERS	INCHES		MILLI-METERS
FRACTIONS	DECIMALS		FRACTIONS	DECIMALS	
	.00394	.1	15/32	.46875	11.9063
	.00787	.2		.47244	12.00
	.01181	.3	31/64	.484375	12.3031
1/64	.015625	.3969	1/2	.5000	12.70
	.01575	.4		.51181	13.00
	.01969	.5	33/64	.515625	13.0969
	.02362	.6	17/32	.53125	13.4938
	.02756	.7	35/64	.546875	13.8907
1/32	.03125	.7938		.55118	14.00
	.0315	.8	9/16	.5625	14.2875
	.03543	.9	37/64	.578125	14.6844
	.03937	1.00		.59055	15.00
3/64	.046875	1.1906	19/32	.59375	15.0813
1/16	.0625	1.5875	39/64	.609375	15.4782
5/64	.078125	1.9844	5/8	.625	15.875
	.07874	2.00		.62992	16.00
3/32	.09375	2.3813	41/64	.640625	16.2719
7/64	.109375	2.7781	21/32	.65625	16.6688
	.11811	3.00		.66929	17.00
1/8	.125	3.175	43/64	.671875	17.0657
9/64	.140625	3.5719	11/16	.6875	17.4625
5/32	.15625	3.9688	45/64	.703125	17.8594
	.15748	4.00		.70866	18.00
11/64	.171875	4.3656	23/32	.71875	18.2563
3/16	.1875	4.7625	47/64	.734375	18.6532
	.19685	5.00		.74803	19.00
13/64	.203125	5.1594	3/4	.7500	19.05
7/32	.21875	5.5563	49/64	.765625	19.4469
15/64	.234375	5.9531	25/32	.78125	19.8438
	.23622	6.00		.7874	20.00
1/4	.2500	6.35	51/64	.796875	20.2407
17/64	.265625	6.7469	13/16	.8125	20.6375
	.27559	7.00		.82677	21.00
9/32	.28125	7.1438	53/64	.828125	21.0344
19/64	.296875	7.5406	27/32	.84375	21.4313
5/16	.3125	7.9375	55/64	.859375	21.8282
	.31496	8.00		.86614	22.00
21/64	.328125	8.3344	7/8	.875	22.225
11/32	.34375	8.7313	57/64	.890625	22.6219
	.35433	9.00		.90551	23.00
23/64	.359375	9.1281	29/32	.90625	23.0188
3/8	.375	9.525	59/64	.921875	23.4157
25/64	.390625	9.9219	15/16	.9375	23.8125
	.3937	10.00		.94488	24.00
13/32	.40625	10.3188	61/64	.953125	24.2094
27/64	.421875	10.7156	31/32	.96875	24.6063
	.43307	11.00		.98425	25.00
7/16	.4375	11.1125	63/64	.984375	25.0032
29/64	.453125	11.5094	1	1.0000	25.4001

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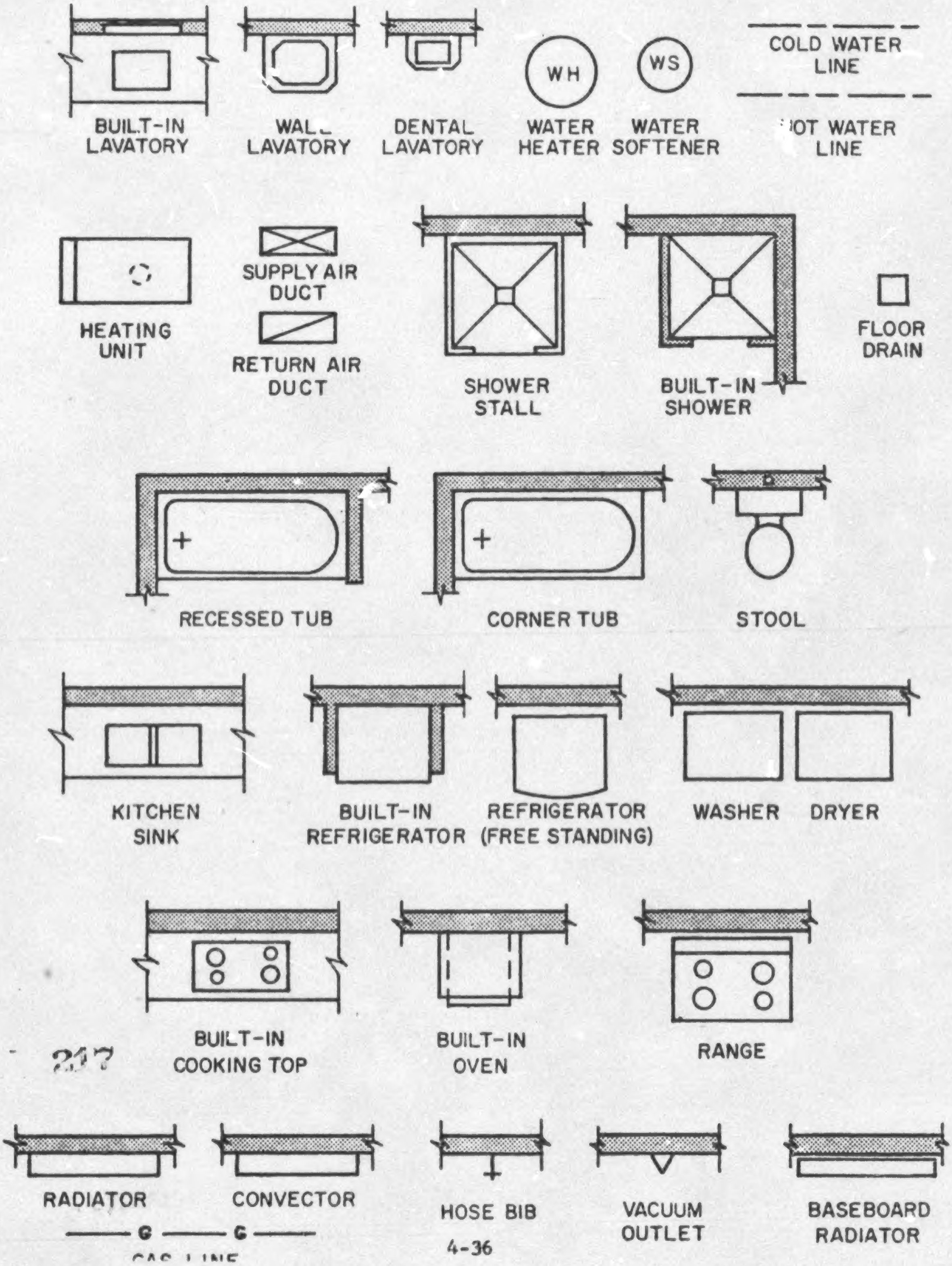
Architectural Symbols

Plumbing Fixtures and Appliances


BUILT-IN LAVATORY
WALL LAVATORY
DENTAL LAVATORY
WH
WATER HEATER
WS
WATER SOFTENER
COLD WATER LINE
HOT WATER LINE
HEATING UNIT
SUPPLY AIR DUCT
RETURN AIR DUCT
SHOWER STALL
BUILT-IN SHOWER
FLOOR DRAIN
RECESSED TUB
CORNER TUB
STOOL
KITCHEN SINK
BUILT-IN REFRIGERATOR
REFRIGERATOR (FREE STANDING)
WASHER
DRYER
BUILT-IN COOKING TOP
BUILT-IN OVEN
RANGE
RADIATOR
CONVECTOR
HOSE BIB
VACUUM OUTLET
BASEBOARD RADIATOR
G
G
GAS LINE

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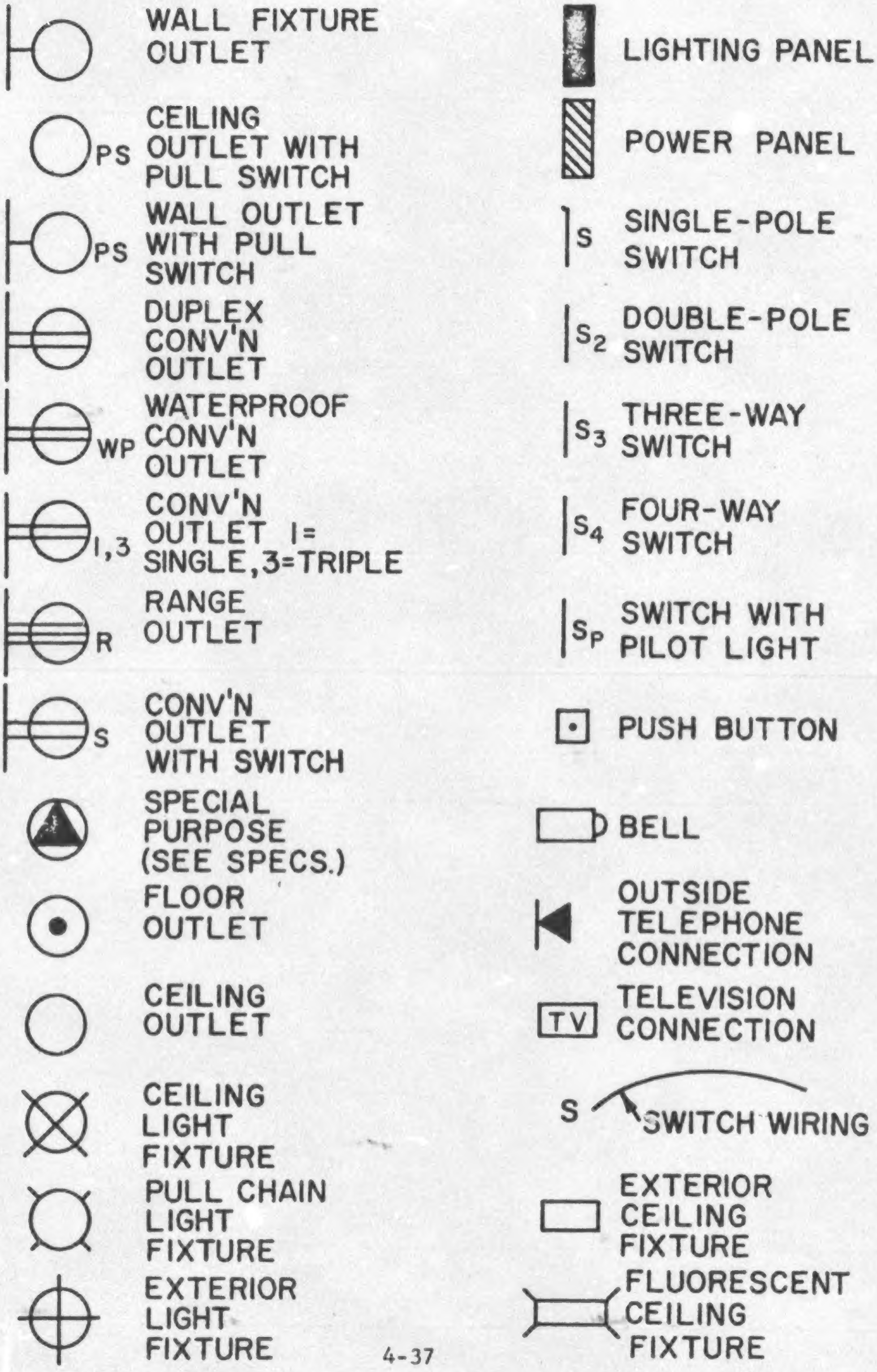
Electrical Symbols


WALL FIXTURE OUTLET
PS
CEILING OUTLET WITH PULL SWITCH
PS
WALL OUTLET WITH PULL SWITCH
DUPLEX CONV'N OUTLET
WP
WATERPROOF CONV'N OUTLET
1,3
CONV'N OUTLET 1= SINGLE, 3=TRIPLE
R
RANGE OUTLET
S
CONV'N OUTLET WITH SWITCH
SPECIAL PURPOSE (SEE SPECS.)
FLOOR OUTLET
CEILING OUTLET
CEILING LIGHT FIXTURE
PULL CHAIN LIGHT FIXTURE
EXTERIOR LIGHT FIXTURE
LIGHTING PANEL
POWER PANEL
S
SINGLE-POLE SWITCH
S2
DOUBLE-POLE SWITCH
S3
THREE-WAY SWITCH
S4
FOUR-WAY SWITCH
SP
SWITCH WITH PILOT LIGHT
PUSH BUTTON
BELL
OUTSIDE TELEPHONE CONNECTION
TV
TELEVISION CONNECTION
S
SWITCH WIRING
EXTERIOR CEILING FIXTURE
FLUORESCENT CEILING FIXTURE

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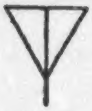
Electronic Symbols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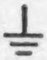
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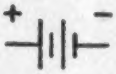
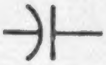


BATTERY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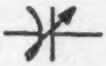
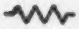
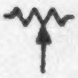
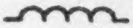
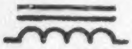
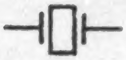

VARIABLE CAPACITOR


RESISTOR


POTENTIOMETER


INDUCTOR AIR CORE


INDUCTOR IRON CORE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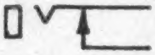
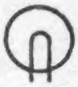
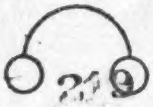
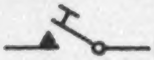
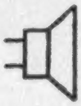
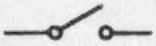

JACK

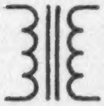

LAMP

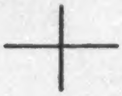

HEADPHONES

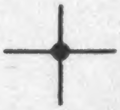

KEY

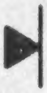

SPEAKER


SWITCH


TRANSFORMER


WIRES CROSS NOT CONNECTED


WIRES CONNECTED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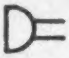
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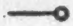
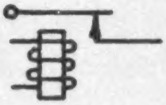

TERMINAL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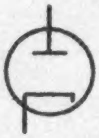
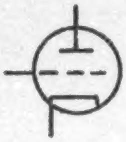

DIODE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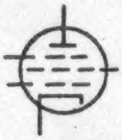
PENTODE

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DIFFERENCES IN SYMBOLIZATION FOR POSITIONAL AND FORM TOLERANCES

Item	International ISO/TC 10 (Symbols mandatory)	American USASI Y14.5 (Symbols optional)	British BS 308 (No symbols-equivalent terms)	Canadian B 78.1
Straightness	—	—	STR TOL	STRAIGHT WITHIN
Roundness (circularity)	○	○	RD TOL	ROUND TOL
Profile of any line	⌒	⌒	Not specified	Not specified
Flatness	▱	▱	FLAT TOL	FLAT WITHIN
Cylindricity	⌭	⌭	CYL TOL	Not specified
Profile of any surface	⌓	⌓	TOL ZONE	TOL ZONE
Parallelism	//	∥	PAR TOL	PARALLEL TO
Perpendicularity (squareness)	⊥	⊥	SQ TOL	SQUARE WITH
Angularity	∠	∠	ANG TOL	ANG TOL
Runout	↗	↗	Not specified	Not specified
True position	⌖	⌖	POSN TOL	LOCATE WITHIN
Concentricity	◎	◎	CONC TOL	CONCENTRIC TO
Symmetry	≡	≡	SYM TOL	SYMMETRICAL WITHIN
Datum feature	$\boxed{\text{A}}$▲	$\boxed{\text{-A-}}$	⟋—A	⟋—A
True position dimension	$\boxed{127}$	$\boxed{5.000}$	5.000 TP	5.000 (TP)
Maximum material condition	Ⓜ	Ⓜ	MMC	MMC
Regardless of feature size	Not specified	Ⓢ	Not specified	Not specified
Tolerance	Total value specified	Total value specified except where radial (half) value is an option.	Total value specified	Total value specified
Diameter	Ø	DIA	DIA or Ø	DIA or Ø
Shape of tolerance zone	Zone is a width in direction of leader arrow. Ø specified where zone is circular or cylindrical.	DIA, TOTAL, or R specified as applicable for positional tolerances. Otherwise, not specified and diameter or width implied as applicable.	DIA or WIDE specified as applicable.	FIM or DIA specified when considered necessary.
Sequence within geometric tolerance notation	1st-Geometric characteristic symbol 2nd-Tolerance value & modifier 3rd-Datum reference & modifier	1st-Geometric characteristic symbol 2nd-Datum reference & modifier 3rd-Tolerance value & modifier	1st-Geometric characteristic term 2nd-Tolerance value & modifier 3rd-Datum reference & modifier	1st-Geometric characteristic term 2nd-Datum reference & modifier 3rd-Tolerance value & modifier

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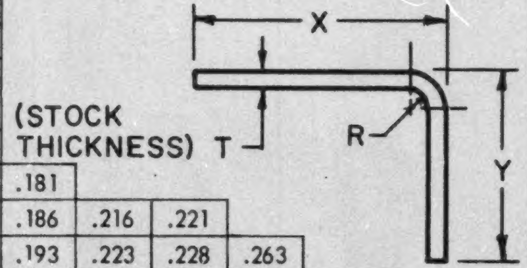
Precision Sheet Metal Set-Back Chart

MATERIAL THICKNESS

90 DEG. BEND RADIUS

	.016	.020	.025	.032	.040	.051	.064	.072	.078	.081	.091	.102	.125	.129	.156	.162	.187	.250
1/32	.034	.039	.046	.055	.065	.081	.102	.113	.121	.125	.139							
3/64	.041	.046	.053	.062	.072	.090	.108	.119	.127	.131	.145							
1/16	.048	.053	.059	.068	.079	.093	.110	.122	.134	.138	.152							
5/64	.054	.060	.066	.075	.086	.100	.117	.127	.138	.144	.158							
3/32	.061	.066	.073	.082	.092	.107	.124	.134	.142	.146	.160							
7/64	.068	.073	.080	.089	.099	.113	.130	.141	.148	.153	.167	.181						
1/8	.075	.080	.086	.095	.106	.120	.137	.147	.155	.159	.172	.186	.216	.221				
9/64	.081	.087	.093	.102	.113	.127	.144	.154	.162	.166	.179	.193	.223	.228	.263			
5/32	.088	.093	.100	.109	.119	.134	.150	.161	.169	.173	.186	.200	.230	.235	.270	.278		
11/64	.095	.100	.107	.116	.126	.140	.157	.168	.175	.179	.192	.207	.236	.242	.277	.284	.317	
3/16	.102	.107	.113	.122	.133	.147	.164	.174	.182	.186	.199	.213	.243	.248	.283	.291	.324	.405
13/64	.108	.114	.120	.129	.140	.154	.171	.181	.189	.193	.206	.220	.250	.255	.290	.298	.330	.412
7/32	.115	.120	.127	.136	.146	.161	.177	.188	.196	.199	.212	.227	.257	.262	.297	.305	.337	.419
15/64	.122	.127	.134	.143	.153	.167	.184	.195	.202	.206	.219	.233	.263	.269	.304	.311	.344	.426
1/4	.129	.134	.140	.149	.160	.174	.191	.201	.209	.213	.226	.240	.270	.275	.310	.318	.351	.432
17/64	.135	.141	.147	.156	.166	.181	.198	.208	.216	.220	.233	.247	.277	.282	.317	.325	.357	.439
9/32	.142	.147	.154	.163	.173	.187	.204	.215	.223	.226	.239	.254	.284	.289	.324	.332	.364	.446
5/16	.156	.161	.167	.176	.187	.201	.218	.228	.236	.240	.253	.267	.297	.302	.337	.345	.378	.459
11/32	.169	.174	.181	.190	.200	.214	.231	.242	.250	.253	.266	.281	.311	.316	.351	.359	.391	.473
3/8	.183	.188	.194	.203	.214	.228	.245	.255	.263	.267	.280	.294	.324	.329	.364	.372	.404	.486



DEVELOPED LENGTH = X+Y−Z

Z = SET-BACK ALLOWANCE FROM CHART

CRITERIA FOR PLACING HANDICAPPED STUDENTS IN REGULAR VOCATIONAL COURSES

Adapted from an Informational Brochure
Developed by Dr. Claire Szoke
for the Springfield Public Schools

A physical or mental handicap does not automatically mean that the student will be unable to function in a regular vocational course without special assistance. The ideal goal of vocational adjustment for the handicapped is participation in an occupation in which the mental or physical disability does not constitute a handicap. Thus, a student confined to a wheelchair might be classified as vocationally handicapped in a welding course but would be a "regular" student in bookkeeping. Social maturity and previous vocational skill preparation are also important.

Determination of the probable degree of vocational handicap is the first step in the placement process. The following criteria will be used to determine whether a student has the interest and ability to succeed in a regular vocational course:

* The student's behavior (as measured by judgements of teachers and counselors) is not a threat to either his own safety or that of others.
* Student expresses interest in course content.
* Recommendations of former and current teachers indicate probable success.
* Results of specially selected vocational aptitude and interest tests are positive. A number of such tests have been developed for poor readers. These include:

  Brainard Occupational Preference Inventory (Pshycological Corporation)--note: reading level is 6.4
  Picture Interest Inventory (McGraw-Hill)
  Bennett Hand Tool Dexterity Test (Psychological Corporation)
  Purdue Pegboard (Science Research Associates)
  Crawford Small Parts Dexterity Test (Psychological Corporation)
  Nonreading Aptitude Test Battery (revised version of the General Aptitude Test Battery; source local Illinois State Employment Service Office)

If physically and mentally handicapped students are to be successfully integrated into regular vocational courses, a careful matching of the student and an appropriate learning environment is essential. The following supportive services are ones that can feasibly be implemented in most public schools:

Materials

- Extensive use of audio visual aids: charts, films, slides, tapes, records, video tapes, overhead transparencies
- Written version of taped materials (hearing impaired)
- Taped versions of written instructional materials

  Mentally retarded or slow learners, e.g., students reading two or more grades below grade level:

  Retarded students who are very poor readers may have up to a sixth grade comprehension level if the material is in oral rather than written form. Sixth grade comprehension level is the level of many popular magazines, newspapers and television shows.

  Visually impaired

  Volunteer service agencies tape textbooks free of charge for the visually impaired -- they cannot do this overnight, however, but must have the text in advance.

- Taped versions of written tests and/or tests administered orally to the individual student (mentally retarded, slow learners, visually impaired)
- Large print versions of instructional material (visually impaired)
- Glossary -- at easy reading level -- of those vocabulary terms essential for the mastery of a particular course. Such a glossary should be used by students both in the vocational class and in their special needs English class. This reinforcement concept is especially valuable for the mentally retarded.

Resources

- Student note-takers (classmate makes carbon copy of his class "lecture" notes for hearing impaired student)
- Student teams (pairing special needs student with one or more non-handicapped classmates). If all the students in a class frequently work in pairs or small groups then the handicapped/disadvantaged student will not feel "singled out" for special assistance

- Individualized tutoring (out-of-class assistance by special education staff and/or special tutor, e.g., students from Sangamon State University; this service could, when needed, include a reader for the visually impaired or a person skilled in sign language to assist the hearing impaired student)
- Instructor aide
- Team teaching (special education teacher in class to assist regular vocational teacher; this is now being done in at least one Springfield Middle School)

CLASSROOM PROCEDURES HELPFUL TO THE SPECIAL NEEDS STUDENT

Mentally retarded or slow learner

- Emphasize hands-on experience.
- Use media (video tapes, films, filmstrips, overhead transparencies, charts, taped materials) to reinforce basic concepts.
- Use a variety of teaching methods -- some students have a short attention span. They will be happier and more successful if given several short tasks during an hour. If they need a lot of "drill" at a certain point, present it in a different way each time.
- Use task analysis, e.g., breakdown of a process into its component parts and the mastery of each task before moving on to the next stage.
- Allow ample time to complete a task -- some students take longer than others to perform a task. Rushing them will only make them more anxious and thus more likely to make errors.
- Emphasize the positive -- comment on what the student does right, rather than only pointing out errors.
- Keep required bookwork to a minimum.

Physically handicapped (orthopedically, hearing, visually impaired)

- Orientation: A small group orientation session should be held for the more seriously physically handicapped students prior to the first class. This orientation should be conducted jointly by the vocational teacher and a special education staff member. If possible, such orientation periods should be scheduled at a time when class is not in session. Such an orientation session should include:
    - Information regarding special equipment and resources available
    - Tour of the classroom laboratory to acquaint student with location of equipment and supplies (this is essential for the visually impaired)

- Opportunity for hands-on trial of basic equipment -- this will enable both the student and teacher to determine what adjustments might need to be made

A separate but similar orientation session should be held for mentally retarded students.

Hearing impaired

- Teacher and deaf student should cooperatively develop some simple signs.
- Be careful in using words with multiple meanings when talking to lip-reading hearing impaired students.
- Speak distinctly and slowly, use simple sentences, and look directly at lip-reading hearing impaired students.
- Emphasize demonstrations rather than verbal explanations.

Visually impaired

- Orderly workshop and individualized instruction regarding the use of each piece of equipment are absolutely essential.
- Give the visually impaired student ample time for accumulating finger knowledge -- teacher must aid student in moving fingers for gathering information.

SUGGESTIONS FOR EQUIPMENT MODIFICATION

Hearing impaired

- A red light installed next to the switch indicating when the machine is in operation
- Bells connected to a light that turns on when the bell rings; applicable on typewriters, class bells, timers, fire alarms, and emergency stop procedures

Visually impaired

- Control dials and switches that are easily accessible; special control dials with actual rather than visual markings; for this one can use brailled tape or raised marks (e.g., dots of Elmer's glue)
- Auditory rather than visual warning signals
- Guard plates (where feasible) on power equipment
- Specially designed measuring tools, e.g., audible multimeter, audible electronic level, brailled ruler -- see *Aids and Appliances* 18th ed., 1973, American Foundation for the Blind.

Orthopedically impaired

- Work tables which can be adjusted to various heights

- * Semi-stationary equipment should be put on variable height bases.
- * Sinks and water controls should be accessible to students in wheelchairs.
- * Guard plates (where feasible) on power equipment; machine switches on power equipment may need to be moved for easier accessibility.
- * Extra large handles on hand tools for easy use by students with weak hands

The following minor adptions which are desirable for orthopedically impaired home economics students are representative of quick, low-cost modifications which might be made or purchased for handicapped students in other vocational classes:

- * Cutting board mounted on suction cups so that students with only one hand or with minimal strength would not have to be concerned with holding the board steady; peeling screw to hold vegetables to be peeled
- * Electric scissors for students with minimal motor control
- * Grocer's hook for reaching small items without the student's getting out of wheelchair
- * Electric mixer with a level control instead of the dial-type speed control (also useful for the visually impaired)
- * Place a lightweight sewing machine on a tray fitted over the arms of a wheelchair.

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